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VOL. 7. 30TH JUNE, 1941. PART 5.

A CONSIDERATION OF THE CEPHALIC STRUCTURES AND SPIRACLES OF THE FINAL INSTAR LARVAE OF THE ICHNEUMONIDAE (HYM.).

By BRYAN P. BEIRNE, B.Sc., F.R.E.S.

A number of descriptions and figures have been published from time to time of the mouth parts and accessory structures of the larval heads of Ichneumonidae and Braconidae. It seems to have been realised only in the past ten years or so that head characters may have some systematic value. Thorpe (1930) in a paper on the parasites of the pine-shoot moth *Rhyacionia buoliana* Schiff. gives figures of a number of species, and since his work a number of papers have appeared, chiefly in the *Bulletin of Entomological Research,* on the parasites of various insects, giving, in most cases, a number of good figures of the heads of the larvae of the parasites. While the larvae show excellent group, and frequently generic, characters, in the majority of cases specific characters have not been found.

The typical Ichneumonid larva is regularly elliptical in outline, tapering anteriorly and posteriorly, and is composed usually of thirteen segments in addition to the head. The skin is rough and bears a number of setae. The head bears a pair of reduced antennae and is strengthened by sclerotizations along certain lines in the neighbourhood of the orifice of the silk duct and the mandibles. These thickenings take the form of sclerotic pigmented bars or struts, the function of which is to strengthen the head capsule and to provide support for the mandibles. Besides the external cephalic skeleton, there is also an internal system of struts known as the tentorium.

The dried cast skin of the last instar larva is obtained from the cocoon from which the insect has emerged. Sometimes cast skins of previous instar larvae may be found there also. The Ichneumonid cocoon is opened by means of a longitudinal cut and the cast larval skin may be seen inside, together with the cast pupal skin and a certain amount of dried meconium. The larval skin is extracted and softened by leaving overnight in 10 per cent. caustic potash or by boiling in caustic potash or water. After treatment it is washed in acetic acid and mounted without staining in de Fauré's or Berlese's medium. It is inevitable that a certain amount of distortion of the cephalic structures will take place owing to pressure of the cover-glass and shrinkage of the mountant on drying. This may be partly obviated by supporting the cover-glass with small pieces of plasticine.

The larval skin so treated will be found to show the external cephalic skeleton perfectly. The low refractive index of the mountant shows up all the details of the structure. The chief drawback is that the internal tentorial structures are never visible in preparations made from cast skins. As the cast skins are generally the only material available for study, the tentorium is largely disregarded in the present paper.

The positions and degree of development of the various cephalic structures vary enormously in the different groups, but the general arrangement is the same in all.

Thorpe (1930) devised a nomenclature for the more important characters. His nomenclature, with some additions and modifications, is used in the various papers by British authors since that time. This nomenclature is hardly satisfactory. As he states himself: 'The use of these names does not imply any homology with the structures found in the adult.'

Vance and Smith (1933), in a paper on 'The larval head of parasitic Hymenoptera and the nomenclature of its parts,' give an excellent terminology of the various head organs, including the less prominent ones. This nomenclature, with slight simplifications, is used in the present paper.

A somewhat diagrammatic front view of the head of a typical last-stage larva of the parasitic Hymenoptera is shown in Fig. 1.

The typical head is roughly hemispherical and may be divided into three regions: the superior portion or epicranium, the frontal region or frons, and the inferior or mouth region, which is the most important in the present connection.

The epicranium consists of two large symmetrical halves separated by the coronal or metopic suture (Fig. 1, MS) and bordered ventrally by the combined hypostoma (HY), pleurostoma (PL), and lateral portions of the epistoma, and by the

frons (F). The epicranium may be divided into several regions, of which the genal regions (G) immediately above the hypostoma and lateral to the pleurostoma are the most important.

The antennae (AN) are located dorsal to the genal regions and lateral to the frons. They are small, and may be so reduced as to be not readily visible, and are situated each in the centre of a circular or ovoid area, the antennal foramen of Vance and Smith. The word foramen implies an opening and is not a suitable name for this. The term 'antennal socket' (Snodgrass, 1928, p. 57; 1935, p. 109) is preferable.

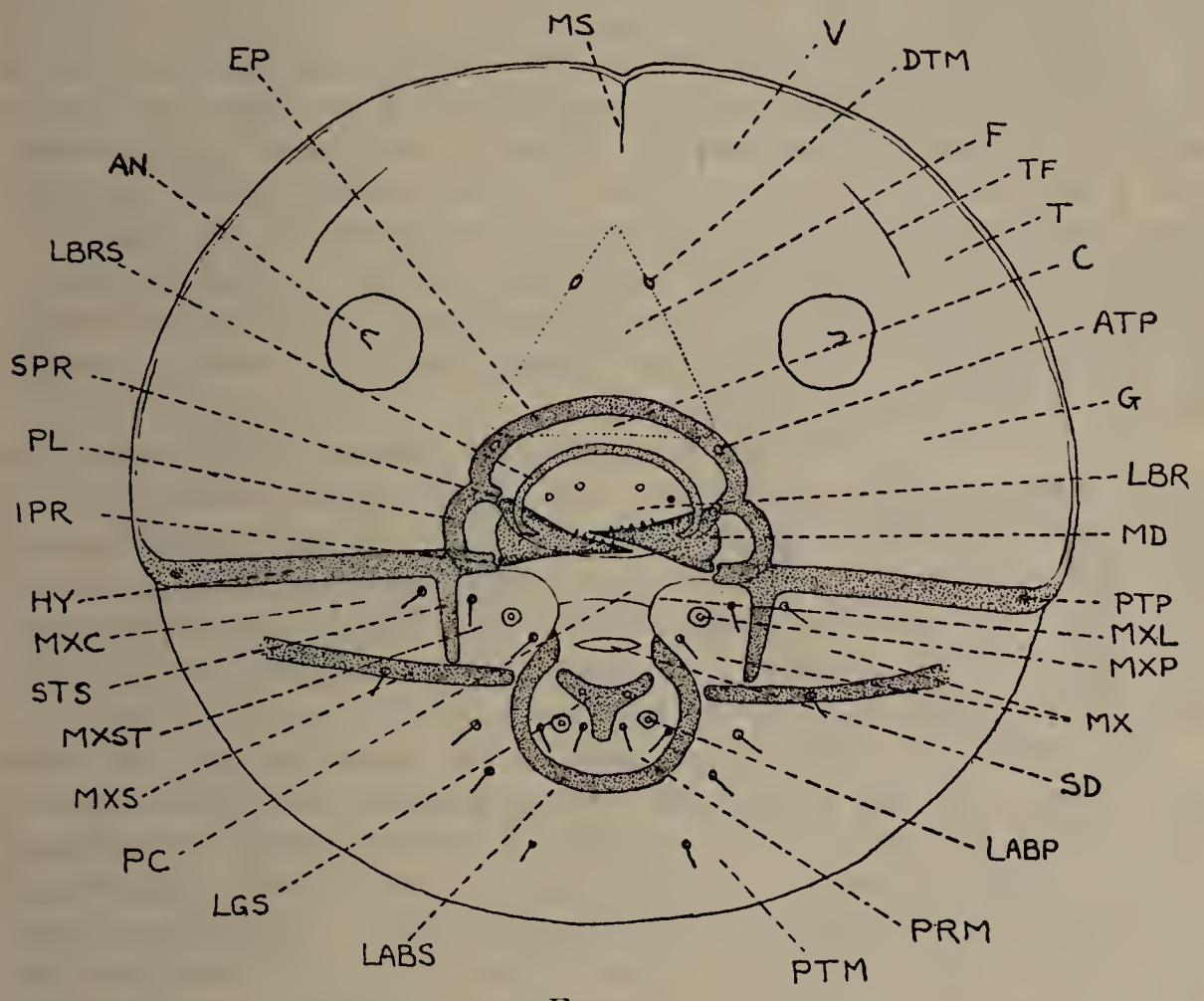

Fig. 1.

(Adapted from Vance and Smith, 1933.)

The frons (F) is a roughly triangular or rectangular area in the centre of the face and is bordered on its ventral edge by the epistoma.

The clypeus (C) and the labrum (LBR) lie inferior to the frons and are bordered ventrally by the preoral cavity, dorsally and laterally by the epistoma and pleurostoma. They are generally difficult to separate, and the region including them is usually designated the labrum only. The labrum may be lobed and extend over part or the whole of the mandibles. It usually bears sensillae and setae, and is more or less pigmented.

In forms with toothed mandibles, with a single exception, *Adelognathus;* a semi-circular sclerotic bar is present with the ends resting on the outside of the mandibles. This is the labral sclerome[1] (LBRS), the clypeal arch of Morris, Cameron and Jepson (1937).

The combined epistoma (EP), pleurostoma (PL), and hypostoma (HY) form a striking feature of the head: they are usually well sclerotized and pigmented.

The hypostoma extends laterally on either side as a sclerotized pigmented bar or strut, from a point median or slightly dorsal to the lateral edges of the preoral cavity (PC). This is the mandibular strut of Thorpe (1930) and the linea lateralis of Baumann (1933). On either side of the preoral cavity it meets the pleurostoma (PL), which is a straight or, more usually, curved bar extending dorsally and bearing on either end a ramus for the articulation of the mandibular condyles. The upper or superior pleurostomal ramus (SPR) consists of a simple strut, the superior mandibular strut of Morris (1937). It is undoubtedly part of the pleurostoma. The pleurostoma is the labral strut of Thorpe (1930) and the limbus mandibularis of Baumann (1933).

The lower or inferior pleurostomal ramus (IPR) may be more complicated in structure. In some tribes it divides into two struts, one articulating with the back of the mandible, and one with the lower edge. It is rather doubtful if this ramus is really part of the pleurostoma, it may be a hypostomal structure. The inferior pleurostomal ramus is the inferior mandibular strut of Morris (1937).

The epistoma (EP) is typically in the form of an arch extending over the labral area from a point on either side at the base of the superior pleurostomal ramus and is continuous with the pleurostoma. It frequently is less heavily sclerotized and pigmented medially and, in many forms, the lateral portions extend dorsally as a bar on either side, not meeting across the middle, so that the arch is incomplete.

The mandibles vary greatly in correlation with the feeding habits of the larvae. They are of considerable systematic importance. It appears to be a fairly general rule that larvae which are ectoparasites have mandibles with toothed blades and those which are endoparasites are without teeth on the blades. There seem to be a number of exceptions to this rule, particularly among the Braconidae. The teeth, when present, are situated in two rows, one on the upper edge of the blade, the other on the lower edge, or sometimes on the outside. In

[1] The term ' sclerome ' is, of course, used by the author in the sense of Vance and Smith (1933). Snodgrass (1935, pp. 73, 81) used the term ' scleroma ' in a different sense (G.J.K.).

the majority of cases the upper row is the better developed of the two; and in some the lower row is completely absent. In species which do not use their mandibles these structures may become very much reduced in size or in degree of sclerotization and pigmentation.

The maxillae (MX) lie on either side ventral to the hypostoma, extend laterally from the preoral cavity to the postoccipital suture, and are bordered ventrally by the maxillary scleromes (MXS).

The stipital sclerome (STS) divides each maxilla into two parts. In most cases its dorsal end is fused to the hypostoma, but it is separate in certain Braconidae. The ventral end rests on or near the maxillary sclerome. The stipital sclerome is the maxillary strut of Thorpe (1930), the sclerotic spur of Snodgrass (1935, p. 297), and the limbus maxillaris of Baumann (1933).

The portion of the maxilla anterior to the stipital sclerome is known as the maxillary stipes (MXST) and bears the rudimentary maxillary palps, anterior to which, and bordering the preoral cavity, is the maxillary lobe (MXL). The part of the maxilla posterior to the stipital sclerome is known as the maxillary cardo (MXC).

The maxillary sclerome (MXS) bounds each maxilla on its lower border. It articulates anteriorly with the labial sclerome (LBS) and extends laterally from it. In the majority of cases the posterior part is twisted in relation to the anterior and bears a single seta. The maxillary sclerome is the labial strut of Thorpe (1930), the sclerotic bar of Snodgrass (1935, p. 297), and the linea sublateralis of Baumann (1933).

The labium morphologically includes all the region and structures lying below the orifice of the silk duct and the maxillary scleromes, and extends posteriorly and ventrally to the neck region. It is divided into two parts by the labial or labiostipital sclerome (LABS). The area bounded laterally and ventrally by the labial sclerome and dorsally by the orifice of the silk duct is known as the labiostipites or prementum (PRM), while the remainder of the labium is known as the labiobase or postmentum (PTM).

The labial sclerome (LABS) is in the form of a ring, interrupted dorsally. The orifice of the silk duct is situated between the open ends. Vance and Smith (1933) state that the sclerome may be complete dorsally, and Morris, Cameron and Jepson (1937) figure a *Delomerista* sp. with a complete labial sclerome. But this appears to be rare and was not noticed in any of the genera examined for the present work. The labial sclerome may be complete ventrally or may end in a broadened point which is frequently little sclerotized or pigmented. Where the

maxillary scleromes touch the labial sclerome there are sometimes developed projecting flanges from the lateral edges of the labial sclerome to which the maxillary scleromes apparently articulate. The labial sclerome is the labial ring of Thorpe (1930), the premental sclerite of Snodgrass (1933, p. 297), and the combined limbus labialis (sides) and limbus mentalis (base) of Baumann (1933).

The ventral and lateral edges of the orifice of the silk duct (SD) may be produced and pigmented. In some forms the roof of the hypopharynx below the tips of the mandibles is covered with minute teeth; this is very evident in the Pimplini (Thorpe, 1930) and, to a less extent, in the Ichneumoninae.

The ligular sclerome (LGS) is a Y-shaped pigmented area in the prementum ventral to the opening of the silk duct. The upper arms in many forms are fused with the ends of the labial sclerome. When the labial sclerome is complete ventrally the lower arm of the ligular sclerome may fuse with it. In many groups the ligular sclerome is not well pigmented.

The prementum bears the rudimentary labial palps which are generally similar in structure to the maxillary palps in any one species. The palpi are small circular or ovoid raised areas on the cuticle bearing a number, generally two, of sensory pits or sensoria.

Certain of the maxillary and labial setae are generally present and constant in number and position. There are three pairs on the prementum, one of which is anterior to, and one posterior to the labial palps, and one on the ligular sclerome. The most constant postmental setae are a pair on either side of the labial sclerome and a pair below. There are two, or sometimes three, pairs on the maxillary stipites; one anterior to, one posterior to, and one ventral to the maxillary palps. The anterior pair is sometimes modified as structures resembling the palps but on a smaller scale and bearing a single sensorium. On each maxillary cardo there is typically a single seta near the junction of the hypostoma with the stipital sclerome, and a second near or, more usually, on the maxillary sclerome. Besides those mentioned there are usually a varying number on the labrum, the genal regions, and the postmentum. These vary greatly in number and position in different species of the same genus, in different specimens of the same species, and even on different sides of the same specimen; but in general the labral setae are constant in any one species.

The size and number of the setae are sometimes of systematic importance. They are very much reduced in some groups such as the Anomalini, or abundant, as in the Ophionini; short, as in the Campoplegini, or very long, as in the Poly-

sphinctini. They almost certainly are sensory and are better developed in ectoparasitic larvae than in endoparasitic forms.

Besides the external sclerites there is also an internal system of struts, the tentorium. Thorpe (1930) uses the term tentorium to designate the external structures as well as the internal but, as Vance and Smith (1933) pointed out, this is not accurate. The word tentorium should be used for the internal skeleton only.

The following description, and the figure (Fig. 2) are taken from Vance and Smith (1933).

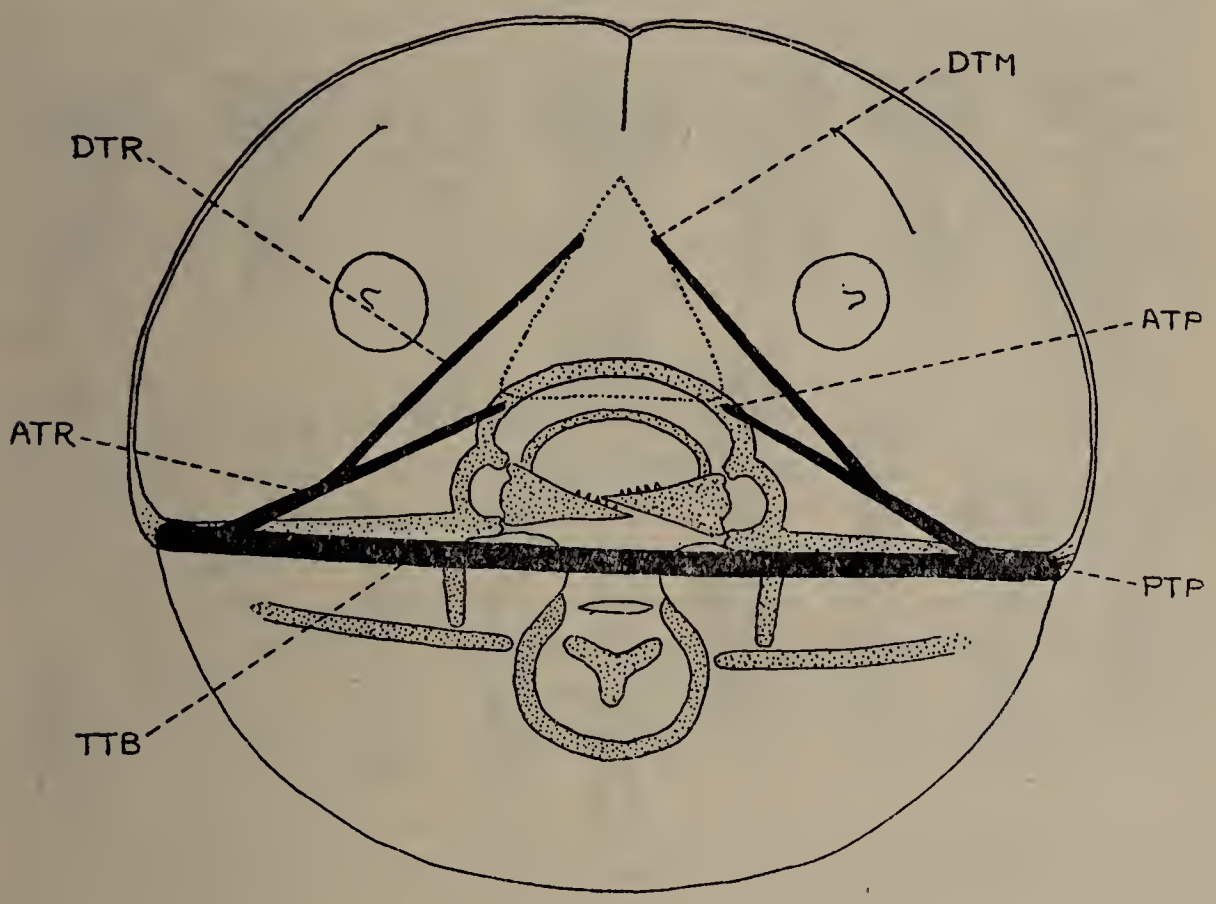

Fig. 2.

The tentorium supports the head internally. From the posterior tentorial pits (Fig. 2, PTP) located at the posterior extremity of the hypostoma (HY) the transverse tentorial bar (TTB) crosses the head internally to a similar point on the other side. In the absence of a fully-developed transverse bar, each of its ends may, however, be present as a short spur extending inward from the posterior tentorial pit. Near each of the lateral extremities of the transverse tentorial bar, an anterior tentorial ramus (ATR) may be directed forward and somewhat dorsally to the lateral region of the epistoma (EP) to terminate at the anterior tentorial pit (ATP); and sometimes a slender dorsal tentorial ramus (DTR) is given off near the middle of the anterior branch and becomes attached near the

dorsal part of the frons (F) at the dorsal tentorial mark (DTM).

The head capsules of the earlier larval instars are rather different from that of the final instar. A number of species have been described and figured by various authors. Their further study will doubtless do much to clarify the classification.

The spiracles are of considerable systematic importance. The type found in the Ichneumoninae and Pimplinae (Fig. 3, a, b, c) is distinctive. The atrium is a large, somewhat flattened, sphere the inside of which is lined with small spine-like projections radiating towards the centre. A short, annularly thickened stalk leads into the thick-walled closing apparatus

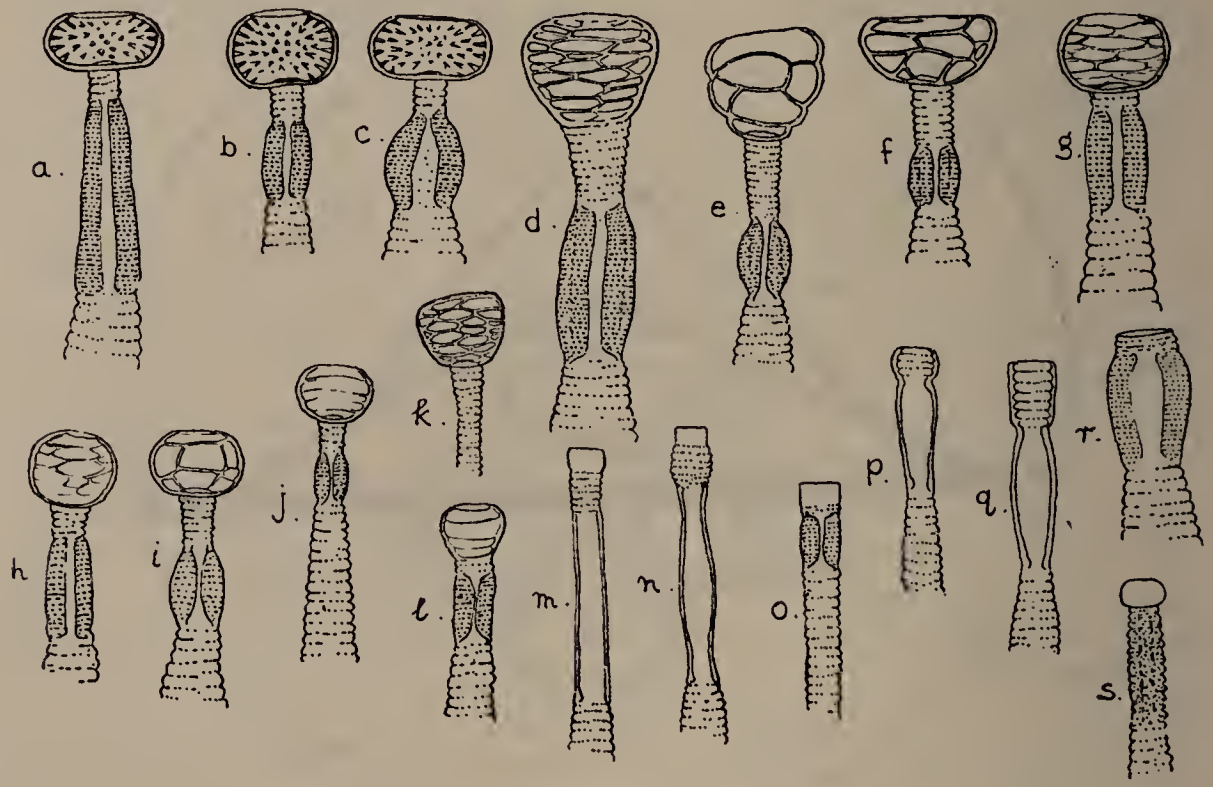

Fig. 3.

which is short in the Pimplinae, long in the Ichneumoninae. In the Cryptinae (Fig. 3, d, e, k) the atrium is roughly in the form of a sphere, somewhat tapered ventrally, and reticulated to a greater or lesser extent; a stalk of varying length leads into the thick-walled closing apparatus. A very similar structure is found in the Tryphoninae (Fig. 3, f-j) and in the Metopiinae (Fig. 3, i). The Lissonotinae (Fig. 3, p, q, r) have a cylindrical atrium with annular thickenings on the inside leading directly into a long thin-walled closing apparatus. *Rhorus* (Fig. 3, r) has a very short atrium and a wide thick-walled closing apparatus. The Bassinae (Fig. 3, m, n) have a short cylindrical atrium without thickenings, a short, annularly thickened stalk and a long, thin-walled closing apparatus. The Anomalinae (Fig. 3, o) have a similarly shaped atrium leading

almost directly into a short, thick-walled closing apparatus. The Mesochorinae (Fig. 3, s) have a small spherical atrium leading directly into a long closing apparatus.

There is sometimes variation in the shape of the spiracles in different species of the same genus, for example *Exenterus* (Fig. 3, f, h). These differences may prove to have some specific value.

Owing to the difficulty in obtaining material of a number of groups the following list must be regarded as being very incomplete, but it contains practically all the parasites of Lepidoptera and many other species commonly encountered. In most cases only one or two species from each group are figured. This implies that the other species that were examined belonging to the same group are very similar in structure. Because one species of a genus or group happens to conform to a particular type it is by no means certain that other species of the same genus or group will conform to the same type. This is well illustrated in the case of the Pimplinae (of various authors).

At the end of the description of each group there is included a list of species the larvae of which have been examined for the present paper, or figured by other authors. Owing to the difficulty of obtaining the literature these lists must in many cases be regarded as incomplete.

Every care was taken to ensure that the specimens were correctly identified. British Museum specimens were used where possible for the figures. The majority of the preparations are deposited in the Department of Entomology, British Museum (Natural History).

The Braconidae are not considered in the present paper. There appears to be no single character of the cephalic structures by which the larvae of the Braconidae may be distinguished from those of the Ichneumonidae.

The following key, which includes also the Chalcidoidea, is based on characters of the living larvae and is adapted from Thompson (1930).

A. Maxillary and labial areas not differentiated; the sensoria below the mouth opening not grouped in definitely circumscribed regions; mandibles usually simple; facial rods usually simple in arrangement and frequently but lightly sclerotized and pigmented; no accessory longitudinal tracheal commissure in the thorax; tracheal system apneustic, metapneustic or peripneustic; endophagous forms sometimes with a tail; cuticle usually colourless, but highly pigmented in the first stage larvae of the Eucharidae and Perilampidae; setae present or absent; ectophagous or endophagous; except in the case of certain parasites of Coccids or the eggs of Lepidoptera, not contracting a respiratory relation with the atmospheric air; cocoons seldom formed .....
CHALCIDOIDEA.

B. Maxillary or labial appendages present or sensoria arranged in definitely circumscribed maxillary and labial areas, at least in the later stages of development; cocoons usually formed ..... ICHNEUMONOIDEA.

(*a*) All facial rods and the mandibles not pigmented, and but lightly sclerotized, only visible with staining ..... ICHNEUMONIDAE, subfamily COLLYRIINAE.

(*b*) An accessory longitudinal tracheal commissure lying in the thoracic segments ventral to the tracheal trunk, towards the ventral part of the body; tracheal system apneustic or peripneustic; nine pairs of functional spiracles usually present in the later stages; a conical tail often present in the endophagous species; three thoracic and ten abdominal segments; mandibles simple or toothed, toothed in endophagous forms, in which case, with the exception of *Adelognathus*, a labral sclerome is always present; some, at least, of the facial rods always more or less sclerotized and pigmented in the final instar; stipital sclerome usually present and always fused to hypostoma, rarely also lightly fused to maxillary sclerome; maxillary sclerome rarely fused posteriorly to hypostoma; ectophagous or endophagous; usually solitary or feebly gregarious ..... ICHNEUMONIDAE.

(*c*) No accessory longitudinal tracheal commissure; tracheal system apneustic or peripneustic; nine pairs of spiracles in the later stages; a globular tail or caudal vesicle often present in the endophagous forms though a trifurcate tail is sometimes present; mandibles sometimes simple but often toothed; labral sclerome apparently not present; stipital sclerome sometimes not fused to hypostoma, sometimes fused to hypostoma only, sometimes to maxillary sclerome only, sometimes to both, in which case the maxillary sclerome is frequently fused posteriorly to the hypostoma and the epistomal arch is usually complete; three thoracic and ten abdominal segments; ectophagous or endophagous, often gregarious, seldom solitary ..... BRACONIDAE.

The classification of the Ichneumonidae is still very unsettled. Morley (1903—1914) divides them into five subfamilies:

(1) The Ichneumoninae which he divides into five tribes, the Listrodromides, the Joppides, the Ichneumonides which he further divides into three subtribes, the Phaeogenides, and the Alomyides.

(2) The Cryptinae with three tribes, the Phygadeuonides with two subtribes, the Stilpnides, and the Cryptides with two subtribes.

(3) The Pimplinae in which he recognizes five tribes, the Xorides, the Pimplides, the Lissonotides, Acoenitides, and the Banchides, including *Exetastes* and *Banchus*: *Glypta* he includes in the Pimplides.

(4) The Tryphoninae with five tribes, the Metopiides, the Sphinctides, the Exochides with two subtribes, the Bassides, and the Tryphonides with four subtribes.

(5) The Ophioninae he divides into nine tribes, the Plectiscides, the Porizonides, the Cremastides, the Campoplegides, the Pristomerides, the Anomalides, the Ophionides, the Paniscides and the Mesochorides.

Schmiedeknecht's (1902—1927) divisions of the Ichneumoninae and Cryptinae are rather similar to those of Morley. The Pimplinae he divided (1906) into five tribes, the Pimplini, the Lissonotini, the Xoridini, the Acoenitini and the Labenini; but in his supplement (1933) he recognized nine other tribes erected since his earlier work. In the Tryphoninae he included the Cteniscini, the Tryphonini, the Mesoleptini, the Bassini, the Sphinctini, the Metopiini, the Tylocomnini, the Exochini and the Orthocentrini. His Ophioninae consist of four tribes not considered here and the Ophionini, the Anomalonini, the Campoplegini, the Paniscini, the Banchini, the Mesochorini, the Pristomerini, the Cremastini, the Porizonini and the Plectiscini.

Hellén (1915) divides the subfamily Pimplinae into six tribes. He includes *Glypta* in the tribe Lissonotides and *Xylonomus* and *Ischnoceros* in a single tribe, the Xylonomides. The tribe Pimplides he divides into eight subtribes, the Rhyssini, the Ephialtini, the Epiurini, the Pimplini, the Polysphinctini, the Lampronotini, the Delomeristini and the Phytodietini.

Cushman and Rohwer (1920) recognize in the Ichneumoninae (Pimplinae *auctt.*) thirteen tribes:

(1) The Lissonotini which they consider to be very closely allied, especially through *Arenetra,* to the Banchini as represented by *Exetastes* and its nearest allies. Roman (1914) places *Exetastes* in the Lissonotini and unites *Banchus* with the Bassini *auctt.,* while Cushman later (1937) expresses the opinion that the Exetastini are not sufficiently distinct to justify their separation from the Lissonotini. *Banchus* and its allies he considers to form the tribe Banchini.

(2) The Glyptini, which they consider to have similar affinities to those of the Lissonotini.

(3) The Lycorini.

(4) The Phytodietini, including the single genus *Phytodietus,* 'although superficially resembling the Lissonotini, it is doubtful if it is closely allied to that tribe. It may be that it has some affinity with the Lycorini, and the ovipositor suggests the possibility that they may have had a common origin with the Cryptinae.' Seyrig (1934) places *Phytodietus* (tribe Phytodietini) next to the Paniscini.

(5) The Theroniini.

(6) The Ephialtini, the type genus of which is *Ephialtes* Schr. (*Pimpla* auctt. and *Pimplidea* Viereck). 'Except in superficial facies the Ephialtini (Pimplini *auctt.*) are very distantly related to the Ichneumonini (Ephialtini and Epiurini and

Delomeristini of Hellén), to which the genera have almost universally been referred.'

(7) The Polysphinctini which they consider to be allied to certain of the Tryphonini, such as *Monoblastus* and *Polyblastus*. The following six tribes they believe to form the true Ichneumoninae (Pimplinae).

(8) The Labenini.

(9) The Rhyssini, related to the Xoridini, the Ichneumonini (Pimplini) and the Labenini.

(10) The Acoenitini. *Collyria*, they state, forms a distinct subtribe of the Mesoleptini. Cushman later (1924) withdrew this opinion. For its sole reception he erected the new tribe Collyriini, which he places next to the Odontomerini.

(11) The Xoridini, related to the Rhyssini and to the Odontomerini.

(12) The Odontomerini.

(13) The Ichneumonini (Ephialtini and Epiurini and Delomeristini of Hellén), rather closely related to the Rhyssini.

Clement (1938) divides the Pimplinae into twenty tribes: the Plectiscini, Xylonomini, Laptonini, Odontomerini, Collyriini, Banchini, Coleocentrini, Neoxoridini (Xoridini *olim.*), Exetastini, Rhyssini, Acoenitini, Lycorinini, Glyptini, Phytodietini, Lissonotini, Theroniini, Ephialtini, Schizopygini, Pimplini and Polysphinctini.

The following classification was adopted on the advice of Mr. J. F. Perkins, who intends to publish it in full, possibly with some amendments, in due course.

Although this classification is based on the adult characters, it agrees remarkably well in the majority of cases with the relationships as shown by the larvae. The genera of species which have been studied for the present paper or figured by other authors are listed in their respective tribes, as recognized by Perkins.

ICHNEUMONIDAE.

1. Ichneumoninae.
   - A. Listrodromini (*Listrodromus*).
   - B. Trogini (*Trogus, Callajoppa*).
   - C. Protichneumonini (*Amblyjoppa*).
   - D. Ichneumonini (*Stenichneumon, Cratichneumon, Barichneumon, Ichneumon, Ctenichneumon, Amblyteles*).
   - E. Platylabini (*Platylabus*).
   - F. Phaeogenini (*Ischnus, Trachyarus, Proscus, Phaeogenes*).
   - G. Alomyini.

2. Pimplinae.
   - A. Pimplini (*Pimpla, Itoplectis, Apechtis, Xanthopimpla, Echthromorpha*).
   - B. ? Theroniini (*Theronia*).

3. Lissonotinae.
   - A. Lissonotini (*Lissonota, Arenetra, Meniscus, Syzeuctus, Glypta, Exetastes*).
   - B. Banchini (*Banchus*).
   - C. Mesoleiini (*Rhorus, Hypsantyx, Mesoleius, Protarchus, Lamachus, Lophyroplectus*).

4. Ophioninae.
   - A. Ophionini (*Ophion, Enicospilus, Allocamptus*).
   - B. Campoplegini (*Charops, Campoplex, Sagaritis, Casinaria, Limnerium, Nemeritis, Phobocampa, Spudastica, Omorgus, Nepiera, Meloboris, Angitia, Trophocampa, Holocremnus, Canidia, Dioctes, Eulimnerium, Anilasta*).
   - C. Cremastini (*Cremastus, Pristomerus*).

5. Anomalinae.
   - A. Anomalini (*Anomalon, Agrypon, Schizoloma, Labrorychus, Aphanistes, Blaptocampus, Trichomma*).

6. Bassinae.
   - A. Bassini (*Bassus, Homocidus, Promethus*).

7. Metopiinae.
   - A. Metopiini (*Metopius, Peltocarus*).
   - B. Exochini (*Triclistus*).
   - C. Orthocentrini.

8. Porizoninae.
   - A. Porizonini (*Thersilochus*).

9. Orthopelminae.
   - A. Orthopelmini (*Orthopelma*).

10. Mesochorinae.
    - A. Mesochorini (*Mesochorus, Astiphrommus*).

11. Acoenitinae.
    - A. Acoenitini (*Phorotrophus*).

12. Collyriinae.
    - A. Collyriini (*Collyria*).

13. Cryptinae.
    - A. Polysphinctini (*Acrodactyla*).
    - B. Rhyssini (*Rhyssa, Thalessa*).
    - C. Ephialtini (*Ephialtes, Iseropus, Delomerista*).
    - D. Xylonomini (*Xylonomus*).
    - E. Odontomerini (*Ischnoceros*).
    - F. Sphecophagini (*Sphecophaga*).

G. Phygadeuonini (*Demopheles, Microcryptus, Oresbius, Acanthocryptus, Hemiteles, Gelis, Panargyrops*).
H. Stilpnini.
I. Cryptini (*Mesostenus, Spilocryptus, Cryptus, Gambrus, Polyaenus, Stenaraeus, Goryphus*).
J. Adelognathini (*Adelognathus*).

14. Tryphoninae.
A. Paniscini (*Paniscus, Parabatus, Phytodietus*).
B. Cteniscini (*Exenterus*).
C. Tryphonini (*Eclytus*).

Key to subfamilies

(does not include Collyriinae for which *cf.* p. 132).

1. Mandibles without teeth; labral sclerome absent ..... 2.
Mandibles with one or two rows of teeth or labral sclerome present ... 12.

2. Labial sclerome well developed and pointed ventrally; pleurostoma lightly pigmented; remaining facial rods and the mandibles not sclerotized or pigmented ..... 6. Bassinae.
Mandibles always more or less sclerotized and pigmented ..... 3.

3. Pleurostoma and epistoma well developed; hypostoma well developed as a bar extending ventrally and laterally on either side; maxillary and stipital sclerome absent; labial sclerome absent or slightly developed; palps with three or more sensoria ..... 4.
Either or both maxillary and stipital scleromes more or less developed; palps rarely with more than three sensoria ..... 5.

4. Mandibles with strongly curved ridged blades (Fig. 4, p); pleurostoma strongly curved; labial sclerome absent ..... 9. Orthopelminae.
Mandibles with blades not or slightly curved, not ridged; labial sclerome sometimes present ..... 1. Ichneumoninae.

5. Epistoma, pleurostoma and stipital scleromes well developed, and in the form of a ring; hypostoma very much reduced; maxillary sclerome reduced ..... 2. Pimplinae.
Epistomal arch never well developed, in conjunction with a reduced hypostoma ..... 6.

6. Mandibles with sclerotized and pigmented ring-like basal portion and sclerotized, pigmented blades, remainder not pigmented (Fig. 4, g); facial setae much reduced ..... 7.
Mandibles not as above ..... 8.

7. Labial sclerome very broad ventrally ..... 11. Acoenitinae (Genus *Phorotrophus*).
Labial sclerome narrow ventrally ..... 10. Mesochorinae.

8. Stipital sclerome absent; epistoma, pleurostoma and hypostoma well developed; facial setae reduced ..... 9.
Stipital sclerome always well developed ..... 10.

9. Labrum with eight sensillae arranged in a horizontal line ..... 5. Anomalinae.
Labrum with more than eight sensillae not arranged in a line ..... 7. Metopiinae.

10. Facial rods lightly sclerotized and pigmented, not well defined; sometimes a short bar immediately above the orifice of the silk duct ..... 8. Porizoninae.

Facial rods always more or less developed and well defined ..... 11.

11. Epistomal arch complete or incomplete; if complete then dorsal ends of labial sclerome usually more strongly pigmented than the remainder; if incomplete then mandibles large, a sclerotized, sometimes pigmented bar extending across the dorsal edge of the preoral cavity from the inferior pleurostomal rami, and hypostoma frequently not pigmented or sclerotized posterior to stipital sclerome, or mandibles smaller and large number of maxillary and labial setae present ..... 3. Lissonotinae.

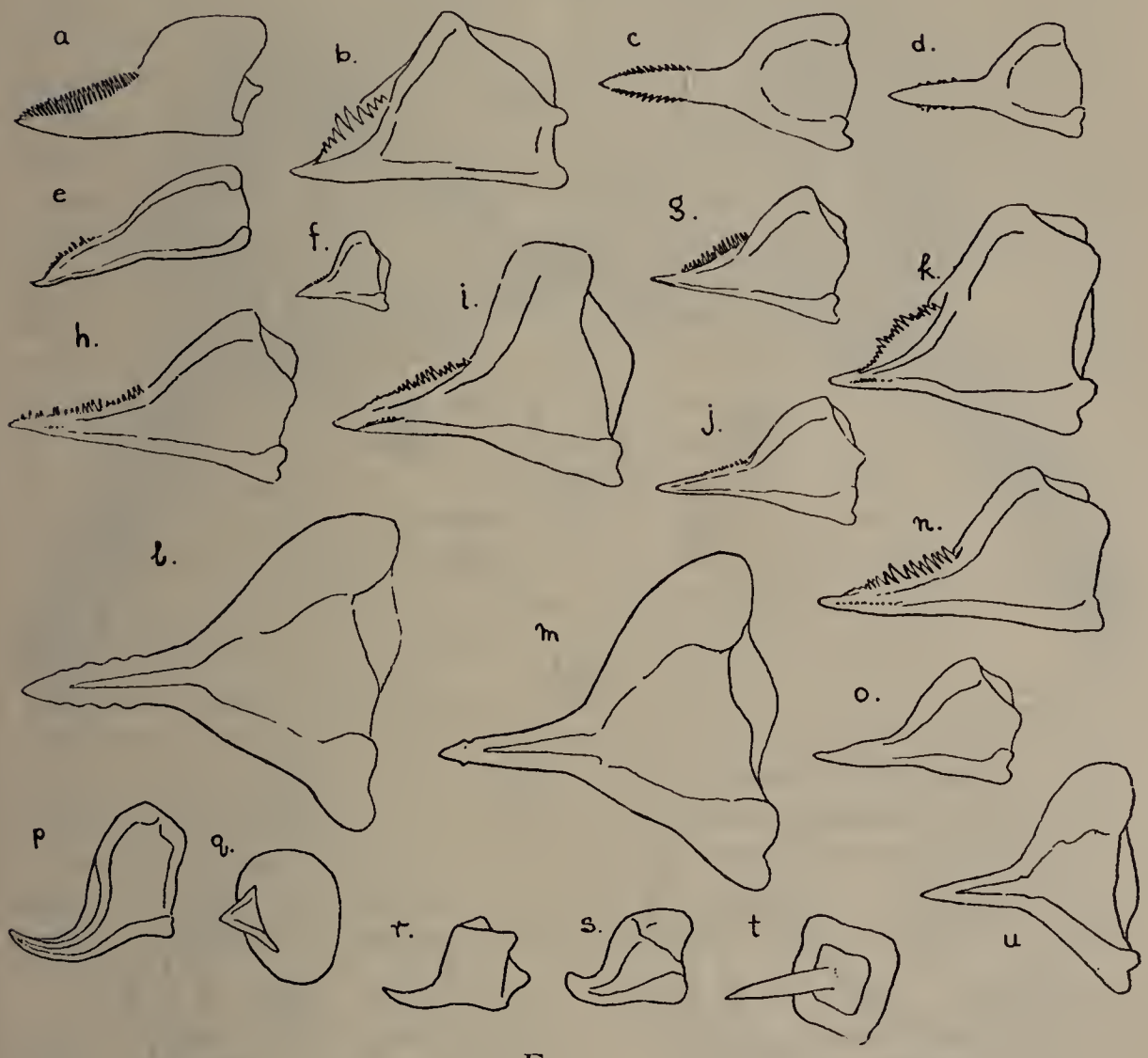

Fig. 4.

Epistomal arch always incomplete; never a bar extending across dorsal edge of preoral cavity; hypostoma always pigmented posterior to stipital sclerome; mandibles moderate or small ..... 4. Ophioninae.

12. Mandibles with one or two rows of teeth, lower or both rows sometimes very much reduced; epistomal arch complete or incomplete, when single row of teeth present then always incomplete, when complete then usually only lightly pigmented medially; never a large ovoid or rectangular pigmented area below labial sclerome .. 13. Cryptinae.

Mandibles without teeth or with one or two rows; when two rows then lower row very much reduced, minute, situated on outside of blade near tip and a large ovoid or rectangular pigmented area always present below labial sclerome; epistomal arch always complete and moderately to strongly pigmented medially ..... 14. TRYPHONINAE.

1. SUBFAMILY ICHNEUMONINAE (Fig. 5). Including the tribes Listrodromini, Trogini, Protichneumonini, Ichneumonini, Platylabini and Phaeogenini.

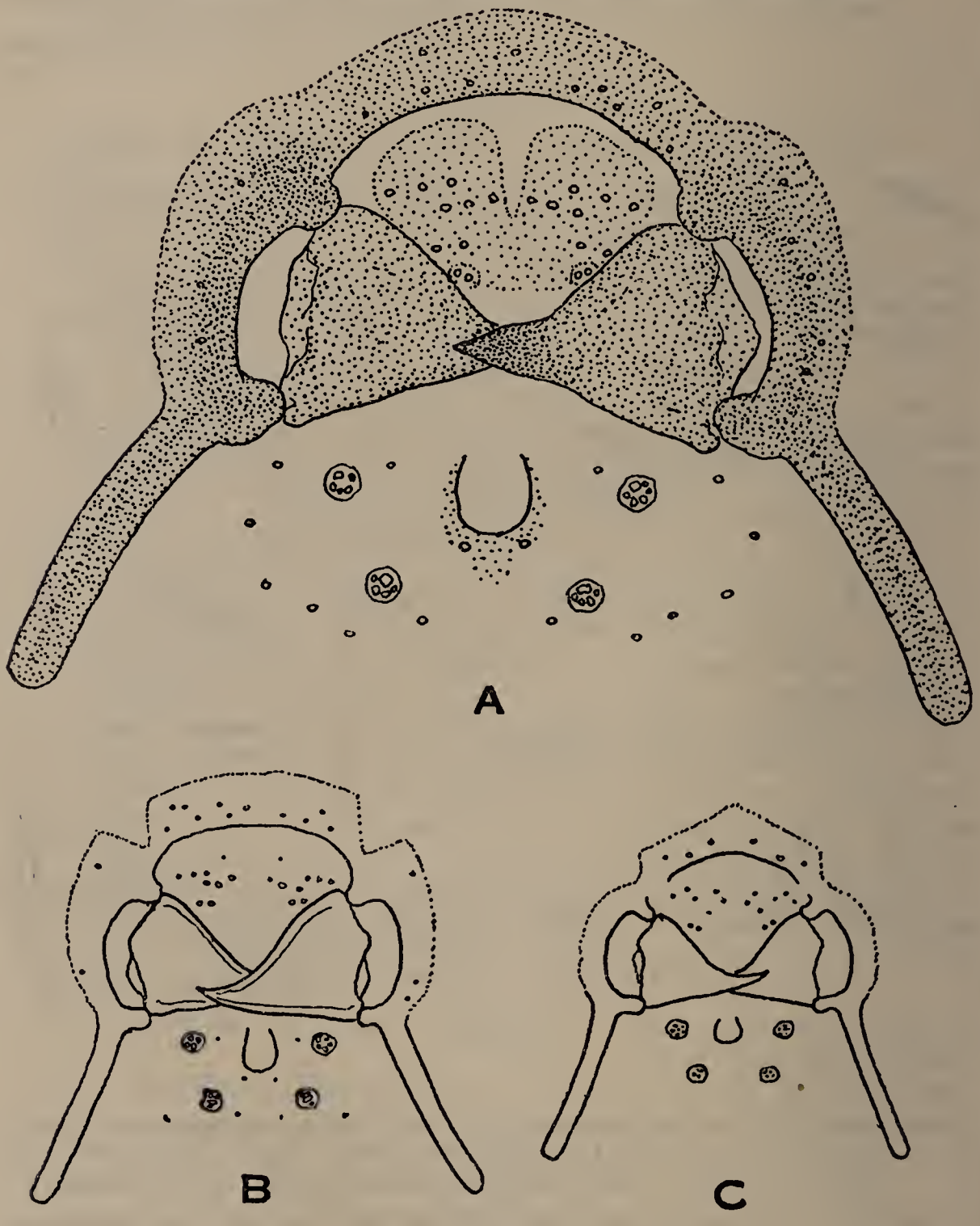

FIG. 5.

Facial rods of Ichneumoninae. a, *Amblyteles armatorius* Forst.; b, *Stenichneumon pictus* Grav.; c, *Proscus suspicax* Wesm.

The structure of the head of the last instar larva is very uniform in the several tribes of this subfamily, and is by no means typical of the larvae of the Ichneumonidae as a whole. Here, as in the Pimplinae and Orthopelminae, the primary function of the facial rods is to provide support for the powerful mandibles. The larvae are internal parasites emerging from lepidopterous pupae.

The chief characteristic is the strongly developed epistoma, pleurostoma, and hypostoma, and the extreme reduction of the remaining scleromes.

The epistomal arch is complete and moderately to strongly sclerotized and pigmented. It bears a number of minute apertures which correspond to setae. The pleurostoma is always well developed and curved. The rami are simple projections to which the mandibles articulate. The hypostoma extends as a straight or slightly curved bar ventrally and somewhat laterally on either side. The stipital and maxillary scleromes are absent. The labial sclerome is slightly pigmented in certain species, but generally it is not visible. The mandibles are large and powerful and are not toothed, the larvae being endoparasitic. The labrum is more or less pigmented and bears a number of setae. The labial palps are represented by two pairs of sensoria, a pair situated on either side just above the mandibles. The maxillary and labial palps bear a number of sensoria, generally about six, but the number varies considerably : this is a characteristic feature of this and certain other groups, such as the Orthopelminae. The maxillary and labial setae are typical in number and position.

Some variation occurs in the shape and degree of pigmentation of the epistoma. In the Phaeogenini it is rather more lightly built than in the larger Ichneumonini and sometimes is pointed dorsally in the mid-line. The mandibles of the Phaeogenini and certain Ichneumonini are more delicately built, with blades longer and more curved than in those of the remaining forms. The Listrodromini approach the Phaeogenini in build.

The following species have been examined :—*Listrodromus nycthemerus* Grav., *Trogus coelopyga* Morl., *T. lapidator* Fab., *Callajoppa lutoria* Fab., *Amblyjoppa laminatoria* Fab., *Stenichneumon pictus* Grav., *S. culpator* Schr., *Cratichneumon annulator* Fab., *Melanichneumon perscrutator* Wesm., *Barichneumon bilunulatus* Grav., *B. heraclianae* Bridg., *Ichneumon extensorius* L., *I. sarcitorius* L., *Ctenichneumon camelinus* Wesm., *Amblyteles armatorius* Forst., *A. oratorius* Fab., *Platylabus pedatorius* Fab., *Ischnus thoracicus* Grav., *Trachyarus corvinus* Thoms., *Proscus suspicax* Wesm., and *Phaeogenes* sp.

Goidanich (1931) and Smith (1932) figure *Phaeogenes nigridens* Wesm. Janvier (1933) figures *Ichneumon macrocerus* Thoms. Meuep (1922) figures *I. bilunulatus* Grav.

2. Subfamily Pimplinae (Figs. 6, 7).

The larvae of the two tribes of this subfamily, the Pimplini and the Theroniini, show no affinities to the larvae of the Ephialtini and other tribes with which they have generally been

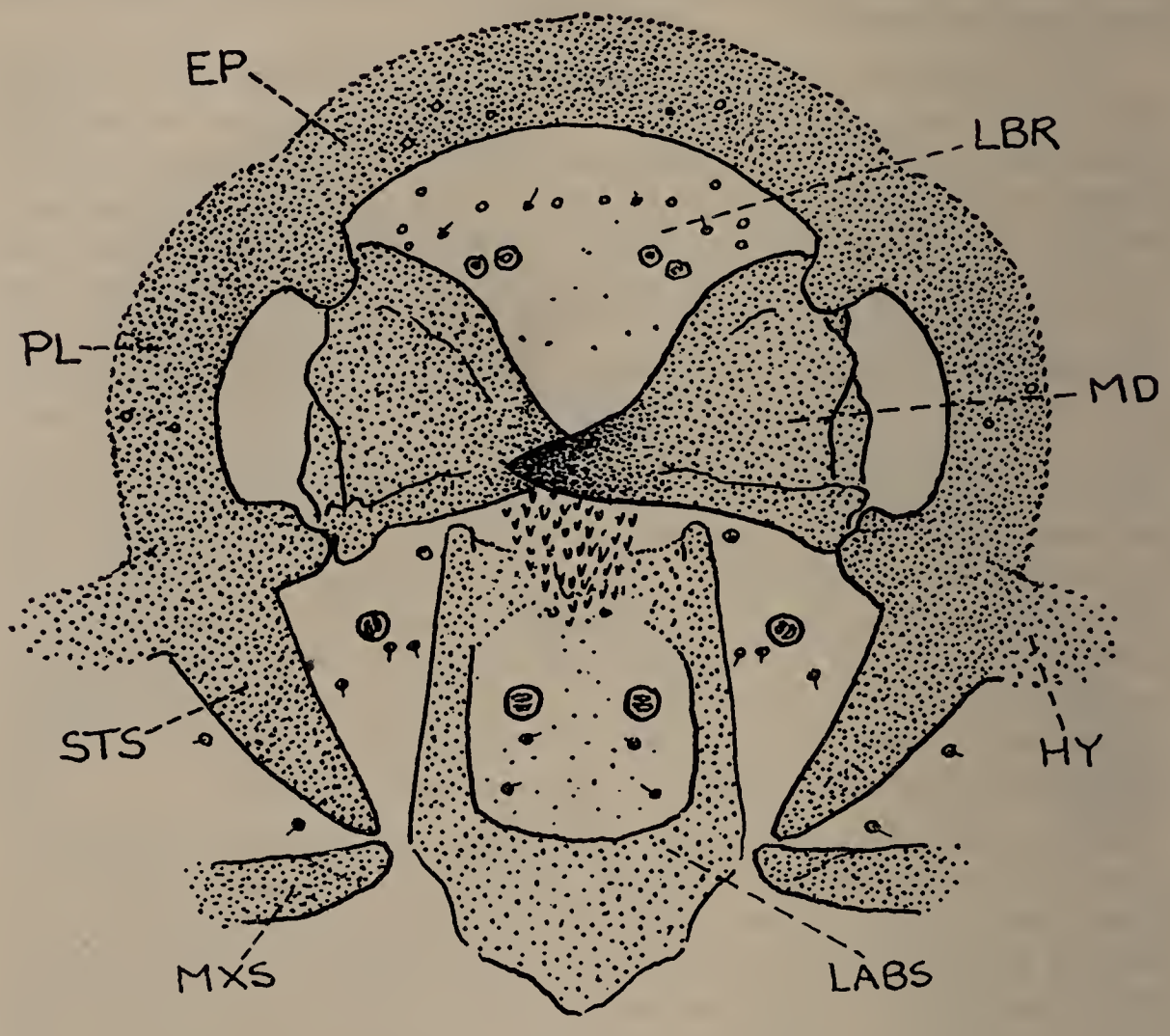

Fig. 6.

Apechtis compunctor L. Lettering as in Fig. 1.

placed. The cephalic structure is very characteristic. In general appearance the structure is like that of the Ichneumoninae, the larvae of which have similar habits, being internal parasites of lepidopterous pupae; and the spiracles (Fig. 3, a, b, c) are of the same pattern.

Key to tribes.

Mandibles with blades bifurcate, upper portion small, curved and sharply pointed, lower portion longer (Fig. 7, e) ..... *B. Theroniini.*

Mandibles simple ..... *A. Pimplini.*

A. Pimplini. (Figs. 6, 7.)

The combined epistoma, pleurostoma, and stipital scleromes form an almost complete ring, broken only at the bottom to admit the labial sclerome. The epistoma bears typically three pairs of setae. The hypostoma is very much reduced, appearing as a short lateral projection from the junction of the pleurostoma and stipital sclerome on either side. The maxillary scleromes are, in general, not well developed except at their anterior ends. The labial sclerome is somewhat elongated dorso-ventrally and considerably broadened basally. The mandibles are large and powerful and are not toothed, the larvae being endoparasitic. Morris, Cameron and Jepson (1937), in a description of *Pimpla* (*Itoplectis*) *alternans* Grav., state that the insides of the blades are armed with bristles, but this was not noticed in any of the species examined by the writer. The region of the hypopharynx, immediately above the orifice of the silk duct and underneath the tips of the mandibles, is covered with a close array of minute teeth. Somewhat similar, but smaller, teeth are visible in the Ichneumoninae. The maxillary and labial palps typically bear two elongated sensoria, but in *Itoplectis* and *Echthromorpha* they usually bear four or more, so that they come to resemble those of the Ichneumoninae. The typical maxillary and labial setae are present. The seta anterior and dorsal to the maxillary palp, on each side, is in the form of a small sensilla resembling the palp in structure but with a single sensorium. The labrum varies considerably in degree of pigmentation and position of the various setae. Typically, it bears six pairs of setae in addition to the two pairs of sensillae which represent the labial palps.

There is some variation in the shape of the labial sclerome in the different genera, which is of systematic value. In the genus *Pimpla* (Fig. 7, b) the lateral arms are somewhat curved, the basal portion is thick, tapering slightly ventrally and ending abruptly. *Itoplectis* (Fig. 7, c) is very similar. *Apechtis* has the lateral arms of the labial sclerome somewhat curved, and the basal portion tapering rapidly to a point. All three genera have a very similar arrangement of setae and sensillae on the labrum, which is not pigmented.

Echthromorpha (Fig. 7, a) is rather different. The labial sclerome is very elongated. The basal part is broad and tapering. The labrum consists of a central, rather elongated, pigmented area bearing three pairs of setae; and a smaller pigmented patch, on either side, near its dorsal end, bearing six setae.

Xanthopimpla (Fig. 7, d) is the most aberrant of the group. The central part of the epistomal arch is but lightly sclerotized

and pigmented. The stipital sclerome is not well differentiated and is fused to the maxillary sclerome, which latter is only well developed anteriorly. The hypostoma is more elongated than in the other genera. The labial sclerome is peculiar: it is only lightly pigmented. The lateral as well as the basal portions are very broad and the dorsal ends of the lateral portions are bent sharply inwards, almost meeting. The labrum bears a pair of well pigmented areas, each with six setae.

The following species have been examined:—*Pimpla instigator* Fab., *P. arctica* Zett., *P. examinator* Fab., *Itoplectis olivalis* Thoms., *Apechtis compunctor* L., *Xanthopimpla pedator* Thoms., *Echthromorpha intricatoria* Fab., *E. formosa* Smith.

Thorpe (1930) figures *Pimpla examinator* Fab. Morris, Cameron and Jepson (1937) figure *P.* (*Itoplectis*) *alternans* Grav. Snodgrass (1935) figures *Itoplectis* sp. Meuep (1922) figures *P. instigator* Fab.

Key to the genera of Pimplini.

(does not include *Allotheria* as no material was available).

1. Maxillary and labial palps with more than three sensoria ..... 2.
   Maxillary and labial palps with not more than three sensoria ..... 3.
2. Labial sclerome pointed ventrally; labrum with three strongly pigmented areas ..... *Echthromorpha.*
   Labial sclerome not or slightly pointed ventrally; labrum not strongly pigmented ..... *Itoplectis.*
3. Labial sclerome lightly pigmented, lateral arms very broad; epistomal arch not heavily sclerotized; stipital sclerome fused to maxillary sclerome ..... *Xanthopimpla.*
   Lateral arms of labial sclerome not broad; stipital sclerome not fused to maxillary sclerome ..... 4.
4. Labial sclerome not pointed ventrally and with lateral arms slightly curved ..... *Pimpla.*
   Labial sclerome pointed ventrally, lateral arms straight ..... *Apechtis.*

B. Theroniini. (Fig. 7, e.)

Meuep (1922) figures the labial sclerome and mandible of the final instar larva of *Theronia atalantae* Poda. The mandible is of the extraordinary shape shown in the figure. The labial sclerome resembles that of certain of the Pimplini such as *Pimpla* or *Apechtis*. The heads of the first and second instar larvae are also figured by him.

There appears to be some doubt as to whether this tribe rightfully belongs to the Pimplinae. As Meuep does not figure the complete head of the final instar larvae no conjectures can be made as to possible relationships.

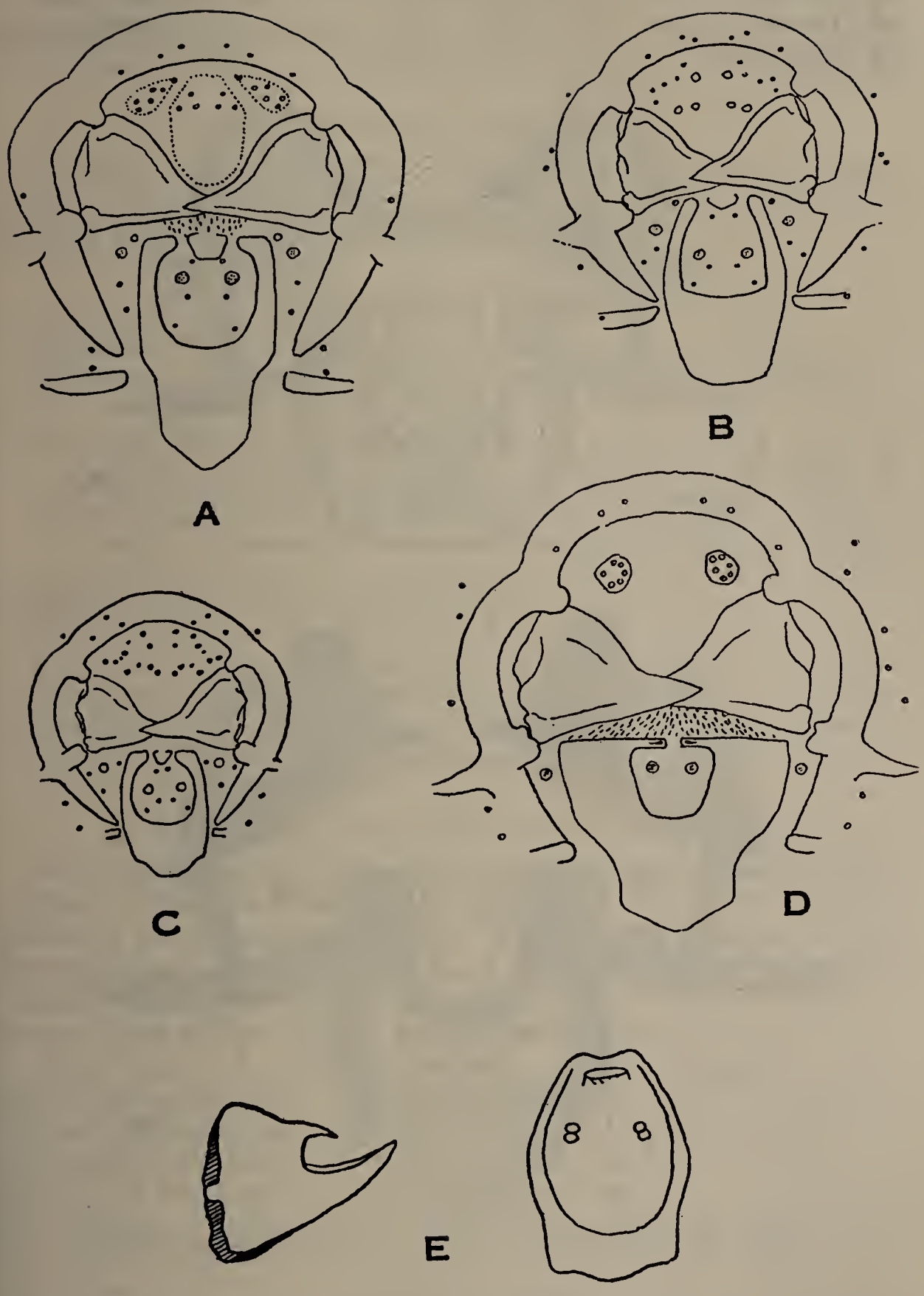

Fig. 7.

a, *Echthromorpha formosa* Smith; b, *Pimpla instigator* Fab.; c, *Itoplectis olivalis* Thoms.; d, *Xanthopimpla pedator* Thoms.; e, Mandible and labial sclerome of *Theronia atalantae* Poda (after Meuep).

3. Subfamily Lissonotinae (Figs. 8-12).

The three tribes of this subfamily show a definite relationship to each other. They also show a distant relationship to the Ophioninae.

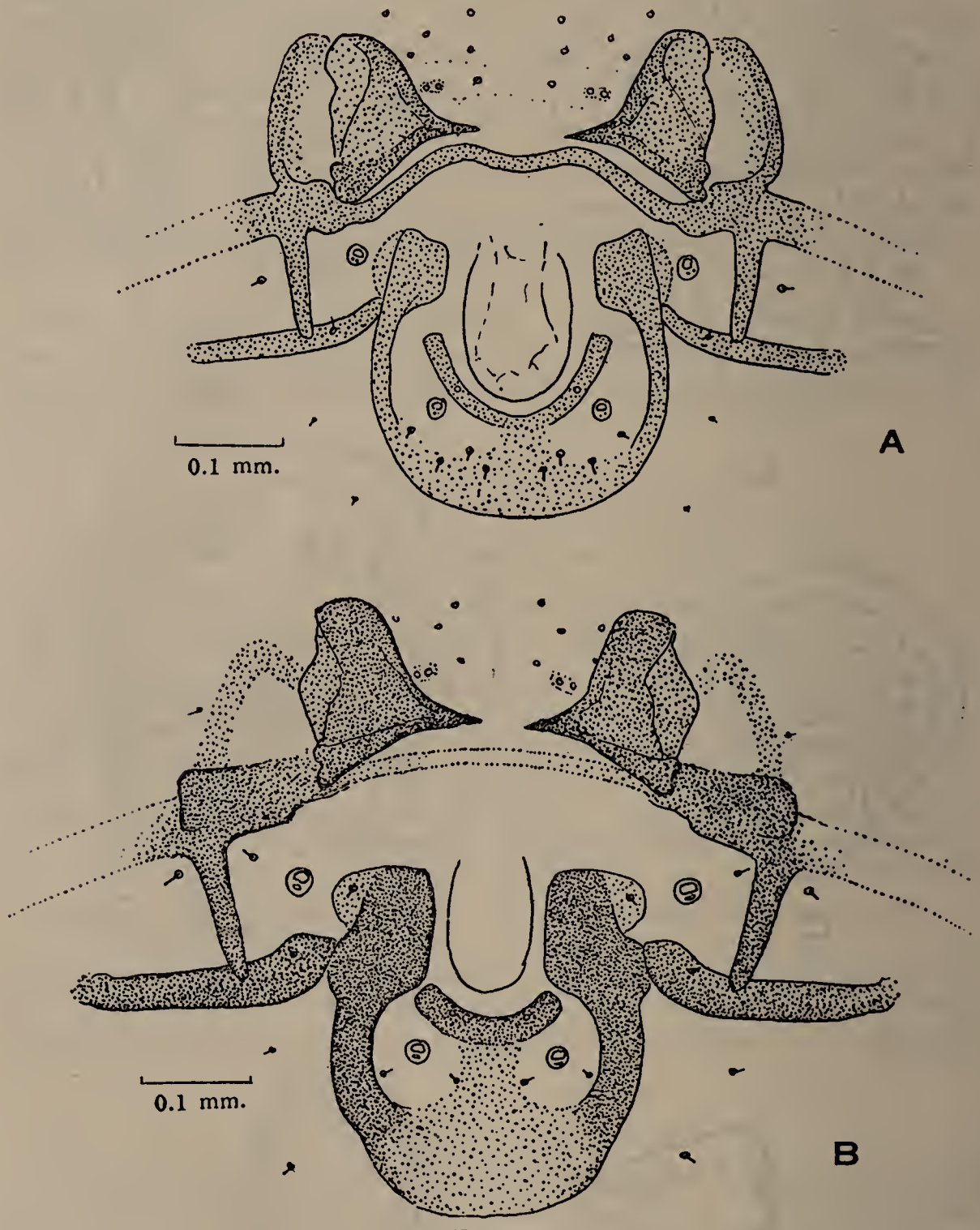

Fig 8.

a, *Syzeuctus maculatorius* Fab.; b, *Meniscus catenator* Panz.

Key to tribes.

Epistomal arch complete or incomplete, when complete the mandibles with blades corrugated, when incomplete then a sclerotized, sometimes pigmented, bar extending across dorsal edge of preoral cavity, and hypostoma frequently not pigmented posterior to stipital sclerome ..... *A. Lissonotini.*

Epistomal arch incomplete; mandibles simple; no bar extending across dorsal edge of preoral cavity; large number of maxillary and labial setae ..... *B. Banchini.*
Epistomal arch complete; mandibles simple; dorsal ends of labial sclerome more strongly pigmented than the remainder ..... *C. Mesoleiini.*

A. Lissonotini. (Figs. 8, 9.)

On the larval characters *Exetastes*, and perhaps *Glypta*, would appear sufficiently distinct from the other genera examined to belong to separate tribes.

Key to genera examined.

1. Hypostoma normally developed ..... 2.
   Hypostoma not pigmented posterior to stipital sclerome; sclerotized bar extending across dorsal edge of preoral cavity ..... 3.
2. A strongly sclerotized and pigmented bar or plate extending across the labrum; mandibles with blades corrugated; no sclerotized bar extending across dorsal edge of preoral cavity ..... *Exetastes.*
   No strong pigmentation of the labral area; mandibles simple; sclerotized bar, not pigmented medially, extending across dorsal edge of preoral cavity ..... *Glypta.*
3. Single corrugation near tip of mandible ..... 4.
   No corrugation near tip of mandible ..... 5.
4. Facial rods thicker; pleurostoma moderately pigmented ..... *Meniscus.*
   Facial rods less thick; pleurostoma not well pigmented ..... *Lissonota.*
5. Facial rods slender; preoral bar well pigmented ..... *Syzeuctus.*
   Facial rods broader; preoral bar not pigmented ..... *Arenetra.*

Genus *Exetastes*. (Fig. 9, b.)

The mandibles of this group are peculiar and characteristic in that the blade is alternately transversely ridged and grooved, giving a corrugated appearance to the edges (Fig. 4, l). The general shape of the mandible is like that of the remaining Lissonotini. *Meniscus* and *Lissonota* have a single ridge and groove, and in this respect approach *Exetastes*.

The epistoma and pleurostoma are strongly developed, broad and pigmented. The anterior tentorial pits are apparent. There is a broad, well pigmented bar or plate extending across the labral area from behind the superior rami: this seems to be part of the labrum, not the epistomal arch as it appears at first sight. The superior pleurostomal rami are small, while the inferior are long and extend as curved bars beneath the mandibles, evidently representing the preoral bar of the remaining Lissonotini. The hypostoma is broad and curves ventrally on either side. The stipital scleromes are short; the maxillary scleromes are long and thick and are twisted posteriorly. The labial sclerome is somewhat broadened and is bluntly pointed ventrally. The ligular sclerome is well pigmented. The typical

facial setae are present and there are usually a few extra pairs on the prementum. In this respect this genus resembles *Banchus*.

The species examined were:—*Exetastes cinctipes* Retz., and *E. illusor* Grav.

Snodgrass (1935) figures *Exetastes* sp..

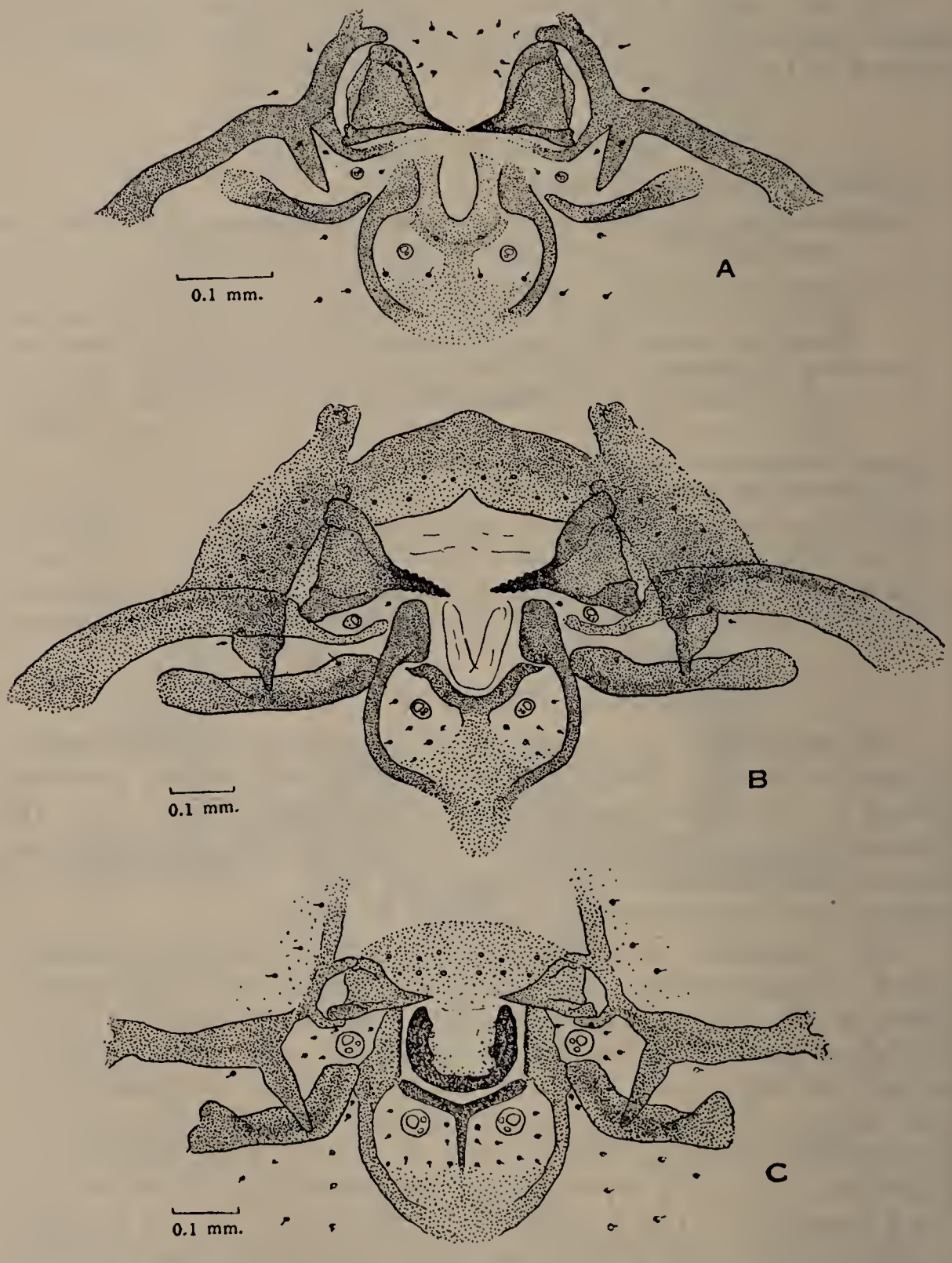

FIG. 9.

a, *Glypta parvicaudata* Bridg.; b, *Exetastes cinctipes* Retz; c, *Banchus femoralis* Thoms.

Genus *Glypta*. (Fig. 9, a.)

The epistomal arch is not complete, the epistoma being only developed just dorsal to the superior pleurostomal ramus on either side. The mandibles are shaped like those of *Lissonota* and its allies (Fig. 4, m). The hypostoma extends laterally and somewhat ventrally on either side. The sclerotic bar across the upper edge of the preoral cavity is present but only pigmented towards the ends. The stipital and maxillary scleromes are well developed. The labial sclerome is roughly circular and resembles that of *Lissonota* and its allies. The orifice of the silk duct is large; the ligular sclerome is well pigmented. The facial setae are typical in number and position, and the palpi each bear two sensoria.

The following species have been examined: *Glypta nigrina* Desv., *G. parvicaudata* Bridg., *Glypta* sp. Cameron (1938) figures *Glypta haesitator* Grav.

Genera *Lissonota, Meniscus, Arenetra* and *Syzeuctus*. (Fig. 8.)

The chief characteristics of these genera are: the hypostoma is not sclerotized or pigmented lateral to the stipital sclerome, and a sclerotic bar extends across the top of the preoral cavity from the inferior pleurostomal ramus on either side.

The facial rods are strongly pigmented. The epistoma is not developed. The pleurostoma is but lightly sclerotized and the superior pleurostomal ramus is not well differentiated. There is some variation in the degree of development of the pleurostoma in the different genera. A sclerotic pigmented bar extends across the upper edges of the maxillae and preoral cavity from the inferior pleurostomal rami on either side. The stipital sclerome rests on the maxillary sclerome which, unlike Ichneumonidae generally, is not twisted. The labial sclerome is rounded and thick. The dorsal ends are broadened and the lateral parts bear projections for the articulation of the maxillary scleromes. Ventrally it is less heavily pigmented and is joined to the lower arm of the ligular sclerome. The upper arms of the ligular sclerome are thick and well pigmented. The shape of the mandibles is rather characteristic: there is a large, rather narrow, basal portion and a narrow pointed blade (Fig. 4, m). The orifice of the silk duct is large. The typical facial setae are present; the maxillary and labial palps bear two, or sometimes three sensoria. The labrum is unpigmented.

There is some variation between the different genera. The genus *Lissonota* more or less fits the above description. The pleurostoma is not well developed dorsally. A characteristic of this and the genus *Meniscus* is that near the tip of the blade of the mandible there is a constriction followed by an enlarge-

ment (Fig. 4, m). Modern classification includes in the genus *Meniscus* only one species, *M. catenator* Panz., the others are put into *Lissonota*. No difference was noted in the larval characters of the species of *Meniscus* examined that would warrant their separation from each other. The pleurostoma is lightly sclerotized and its superior ramus is well defined. Generally speaking the facial rods are much thicker than in *Lissonota*. The anterior ends of the labial sclerome have small flanges projecting laterally. The upper arms of the ligular sclerome are strongly, and the lower very lightly, pigmented.

There is little to distinguish *Arenetra* from *Meniscus* except that the mandibles are without the constriction near the end of the blade and the upper arms of the ligular sclerome are more strongly dorsally directed.

In these three genera the bar across the preoral cavity is not pigmented except near the rami on either side.

Syzeuctus is rather different from these. The facial rods are much less thick, and less pigmented. The pleurostoma is moderately developed, while the bar across the preoral cavity is pigmented to an extent equal to that of the other facial rods. The orifice of the silk duct is large, extending well into the prementum, with the result that the upper arms of the ligular sclerome assume an almost semi-circular shape.

The following species have been examined: *Lissonota setosa* Frc., *L. fletcheri* Bridg., *L.* (*Meniscus*) *pimplator* Zett., *Meniscus catenator* Panz., *Arenetra pilosella* Grav., *Syzeuctus maculatorius* Fab., *S. interstitialis* Cam.

B. Banchini. (Fig. 9, c.)

This tribe comes near the Lissonotini, but is quite distinct therefrom.

The epistomal arch is not present. Laterally, the epistoma and pleurostoma extend as moderately thin sclerotic bars. The inferior pleurostomal ramus is rather long, approaching in shape that of *Exetastes*. The mandibles are small, with rapidly tapering blades. The hypostoma is short and the posterior tentorial pits are evident. The maxillary scleromes are large, twisted posteriorly and bent upwards anteriorly. The labial sclerome is complete ventrally but less heavily pigmented in that region. The ligular sclerome is strongly pigmented. The edges of the orifice of the silk duct are produced and well pigmented: this is a rather characteristic feature. The facial setae are rather abundant: there are a large number on the prementum, the postmentum lateral to the labial sclerome, and the maxillary stipes. The palpi each have three sensoria. The labrum is moderately well pigmented and bears six pairs of setae.

The following species have been examined: *Banchus femoralis* Thoms., *B. volutatorius* L., *B. pictus* Fab.

C. Mesoleiini. (Figs. 10, 11, 12.)

The characteristic feature of this tribe is that the dorsal ends of the labial sclerome are usually broadened, and are always more strongly pigmented than the remainder. The palps are large, with small sensoria.

Key to genera examined.

1. Mandibles consisting of a rounded or ovoid basal portion, which is not well sclerotized or pigmented, and a short sclerotized and pigmented blade (Fig. 4, q) ..... *Rhorus* (*Monoblastus* auctt.).
   Mandibles not as above ..... 2.
2. Mandibles small, with very short blades, lightly sclerotized and pigmented; hypostoma strongly ventrally directed ..... *Hypsantyx*.
   Mandibles not as above; hypostoma not strongly ventrally directed .... 3.
3. Labial sclerome rounded; mandibles small with narrow curved blades; dorsal ends of labial sclerome not broadened ..... *Lophyroplectus*.
   Mandibles larger with broader blades; dorsal ends of labial sclerome obviously broadened ..... 4.
4. Labial sclerome broadened and bluntly pointed ventrally; labrum well pigmented; large number of labral and genal setae ..... *Protarchus*.
   Labial sclerome not or moderately broadened ventrally; labrum not or slightly pigmented; not a large number of labral and genal setae ..... *Mesoleius*, *Lamachus*.

Genus *Rhorus* Först. (*Monoblastus* auctt.). (Fig. 10, b.)

Roman (1914) was the first author to unite *Rhorus mesoxanthus* Grav. with the species comprising *Monoblastus* auctt. Morley (1911) placed *mesoxanthus* in the genus *Ctenopelma* and *Monoblastus* in the same heterogeneous tribe Ctenopelmini Ashmead (1900). Schmiedeknecht (1912, 1913) placed *Monoblastus* in the Polyblastini, and *Rhorus mesoxanthus* next to *Ctenopelma* in the Notopygina. The larva shows a marked resemblance to *Hypsantyx* and, through it, to the remaining Mesoleiini.

The epistomal arch is complete but hardly pigmented. The epistoma, pleurostoma and hypostoma are well developed and in line with each other, the hypostoma pointing sharply ventrally. The rami are short, pointed projections. The anterior tentorial pits are very prominent. The genal regions immediately dorsal to the hypostoma and pleurostoma are pigmented and sclerotized. The mandibles are quite distinctive: each consists of a circular or ovoid basal portion and a short, triangular, pointed blade (Fig. 4, q). The stipital scleromes are rather curved and the maxillary scleromes bent upwards

where they meet the labial sclerome. The labial sclerome is somewhat flattened, but not well sclerotized ventrally. Dorsally, its ends are enlarged and strongly pigmented. The ligular sclerome is well defined. The typical facial setae are present and there are also several extra ones on the postmentum near the sides of the labial sclerome, and on the maxilla

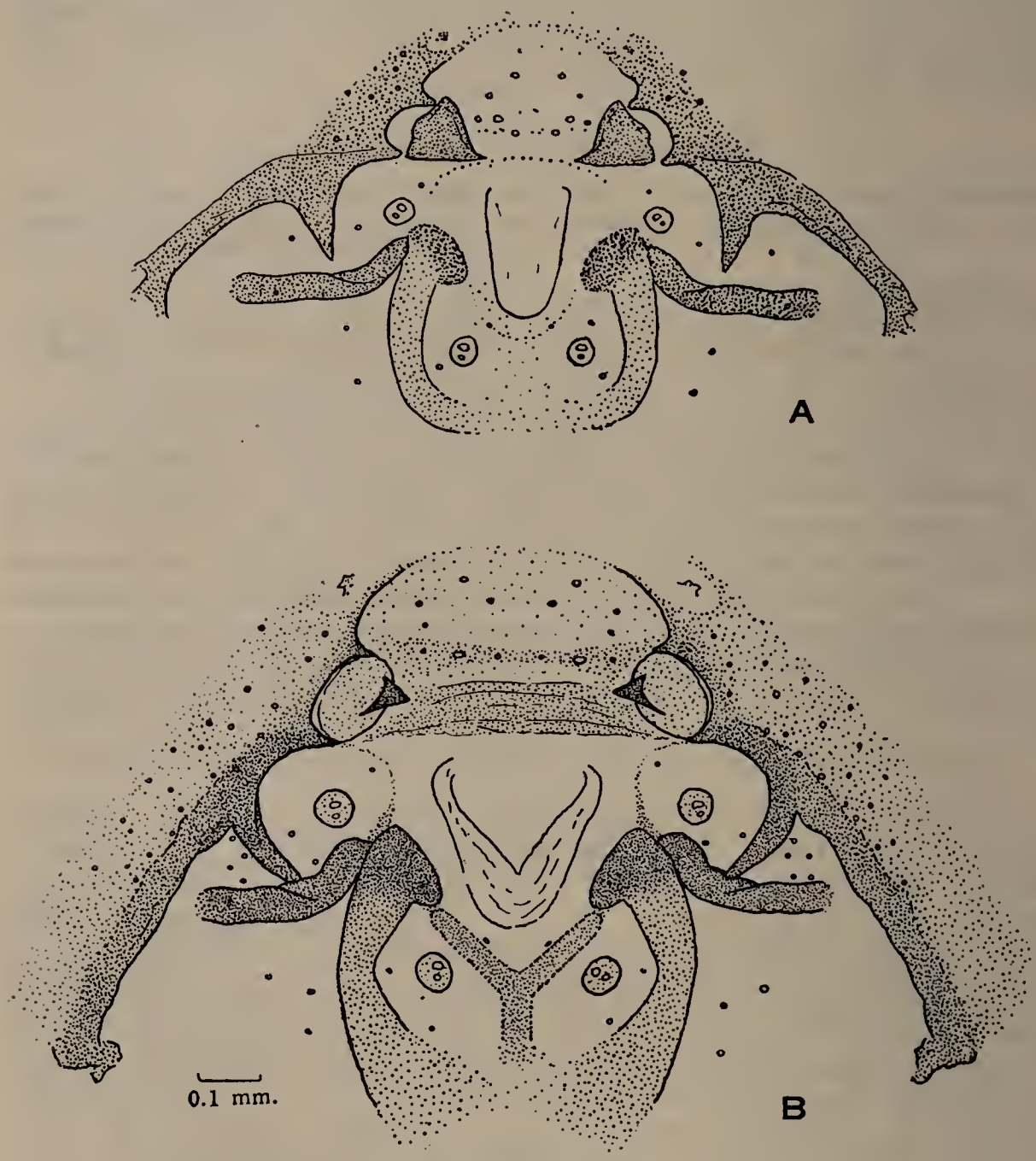

Fig. 10.

a, *Hypsantyx impressus* Grav.; b, *Rhorus mesoxanthus* Grav.

immediately lateral to the stipital sclerome. The palps have each two small sensoria. The labrum is lightly pigmented, with about seven pairs of sensillae. The sclerotized genal regions bear a large number of setae.

The species examined was: *Rhorus* (*Monoblastus*) *mesoxanthus* Grav.

Genus *Hypsantyx*. (Fig. 10, a.)

This genus very closely resembles *Rhorus*, the chief differences being that the mandibles are of quite different structure. They are small, with short pointed blades, and are not well developed. The ligular sclerome is less heavily pigmented, as is the labrum.

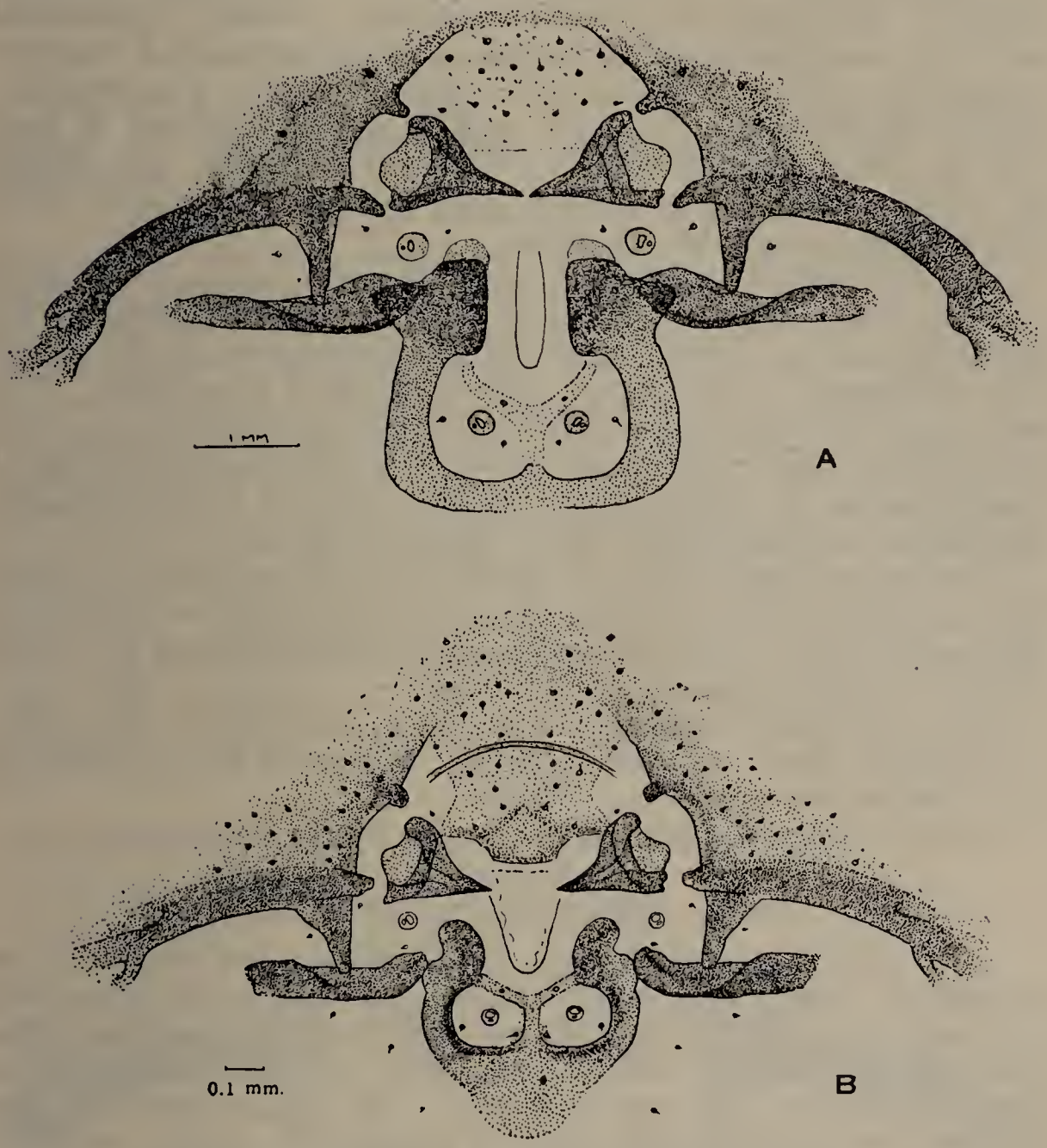

Fig. 11.

a, *Mesoleius tenthredinis* Morl.; b, *Protarchus testatorius* Thunb.

The species examined was *Hypsantyx impressus* Grav.

Roman (1914) suggests that this genus might be related to the Banchini and Bassini. While showing a distinct subfamily relationship to the Banchini, it shows no apparent relationship whatever with the Bassini.

Genera *Mesoleius, Protarchus, Lamachus.* (Fig. 11.)

The epistomal arch is complete. The pleurostoma is broad and the genal regions immediately lateral are pigmented. The mandibles are moderately large with tapering, sharply pointed, blades. The hypostoma curves ventrally on either side and at its ends the posterior tentorial pits are visible. The stipital scleromes are broad basally and the maxillary scleromes twisted. The labial sclerome is complete ventrally: its dorsal ends are broadened, and are more strongly pigmented than the remainder. All three arms of the ligular sclerome are moderately well pigmented, and the orifice of the silk duct is long and narrow. The maxillary and premental setae are typical in number and position. Each palp bears two sensoria. The labrum bears a number of setae.

There is some variation in the different genera. *Mesoleius* has the labial sclerome flattened ventrally, and projections are developed on the lateral edges for the articulation of the maxillary scleromes. The labrum is not strongly pigmented. The setae on the genal regions lateral to the pleurostoma are few in number. *M. tenthredinis* sometimes has the facial rods of a grey colour, as distinct from the other known Ichneumonidae, in which they are always some shade of brown.

Protarchus has the labial sclerome broad ventrally and ending in a blunt point. There are a large number of genal and epistomal setae. The labrum is well pigmented and its shape is rather characteristic.

The following species have been examined: *Mesoleius tenthredinis* Morl., *M. aulicus* Grav., *Mesoleius* spp., *Lamachus* sp., *Protarchus testatorius* Thunb.

Morris, Cameron and Jepson (1937) figure a *Lamachus* sp.

Genus *Lophyroplectus.* (Fig. 12.)

The chief characteristic of this genus is the shape of the mandibles, which are much smaller than those of *Mesoleius* and rather resemble those of certain Campoplegini. The labial sclerome is rounded, broad, and bluntly pointed basally. The dorsal ends are not enlarged as in *Mesoleius* and are only slightly more pigmented than the remainder of the sclerome. There are strong lateral projections for the articulation of the maxillary scleromes. The labrum is pigmented and in shape closely resembles that of *Protarchus.*

One species, *Lophyroplectus luteator* Thunb., was examined.

4. Subfamily Ophioninae. (Figs. 13, 14, 15.)

The three tribes of this subfamily are obviously very closely related to each other.

Key to tribes.

1. Labial sclerome complete and very much broadened ventrally, fused to the ligular sclerome which is also very much broadened; large number of maxillary and labial setae ..... *A. Ophionini.*
   Normal number of maxillary and labial setae ..... 2.
2. Ligular sclerome not sclerotized or pigmented ..... *C. Cremastini.*
   Ligular sclerome always more or less sclerotized and pigmented ..... *B. Campoplegini.*

A. Ophionini. (Fig. 13.)

This is a very distinctive tribe, but is obviously closely related to the Campoplegini, particularly to the genus *Campoplex*.

The epistomal ring is not complete, but the epistoma and pleurostoma are well developed laterally. The hypostoma extends on either side as a thick, strongly pigmented bar which bends sharply downwards at right angles posteriorly, tapering off gradually. The mandibles are very small with rounded tips, and are obviously of little use (Fig. 4, s). The stipital scleromes are narrow, the maxillary scleromes are thick and bend upwards where they touch the labial sclerome. At its posterior end each meets a large, circular, lightly sclerotized area in the angle formed by the bending of the hypostoma. The labial sclerome is large and not so heavily pigmented as the other facial rods. The ligular sclerome is sclerotized and pigmented to a degree equal to that of the labial sclerome, and its three arms are fused to it. The two scleromes are very much broadened, with the result that the two areas of the prementum,

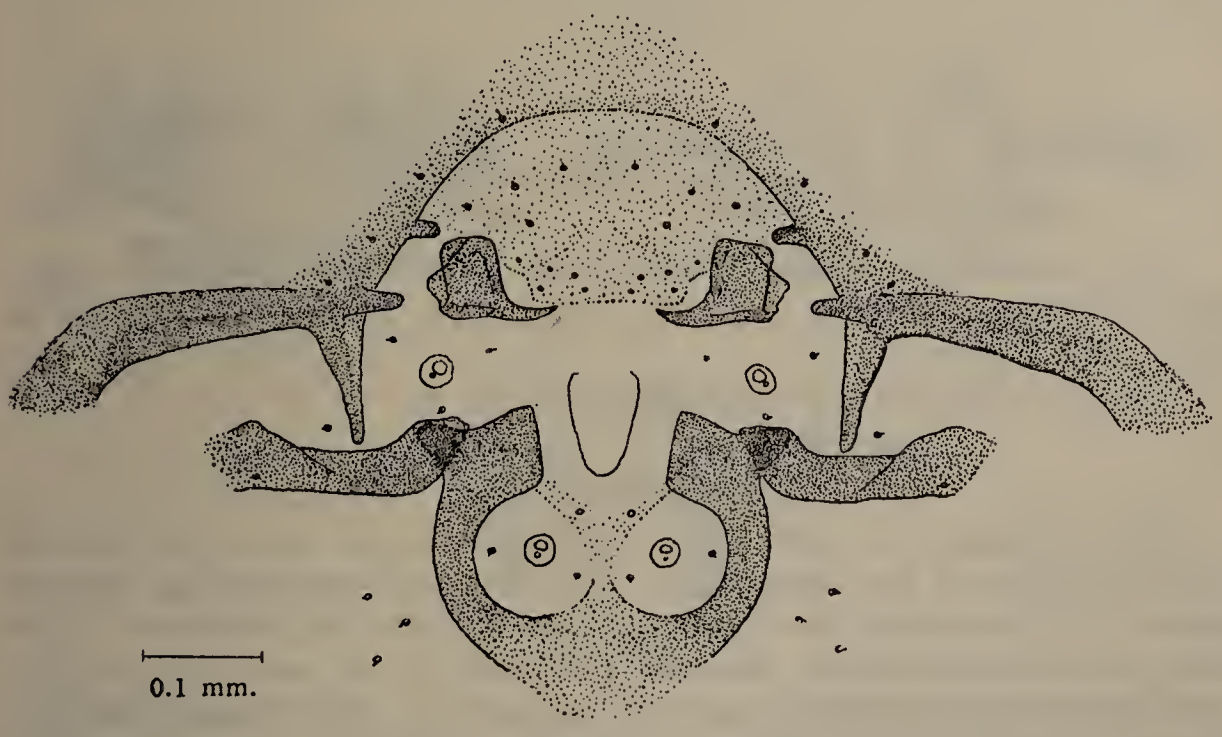

Fig. 12.

Lophyroplectus luteator Thunb.

containing the labial palps, are comparatively small. The labial sclerome is rounded and very much broadened ventrally. The edges of the orifice of the silk duct are produced and somewhat pigmented. The most characteristic feature of the tribe is the extraordinary number of facial setae present; these are most concentrated on the broad basal portion of the labial sclerome. They also occur in numbers on the prementum, the postmentum lateral to the labial sclerome, the maxillary cardo and to a certain extent on the genal regions and on the labrum. The Banchini is the only other tribe which has a similar abundance of facial setae. The palps bear two pits. The labrum is slightly pigmented and bears a pair of ovoid or rectangular pigmented areas.

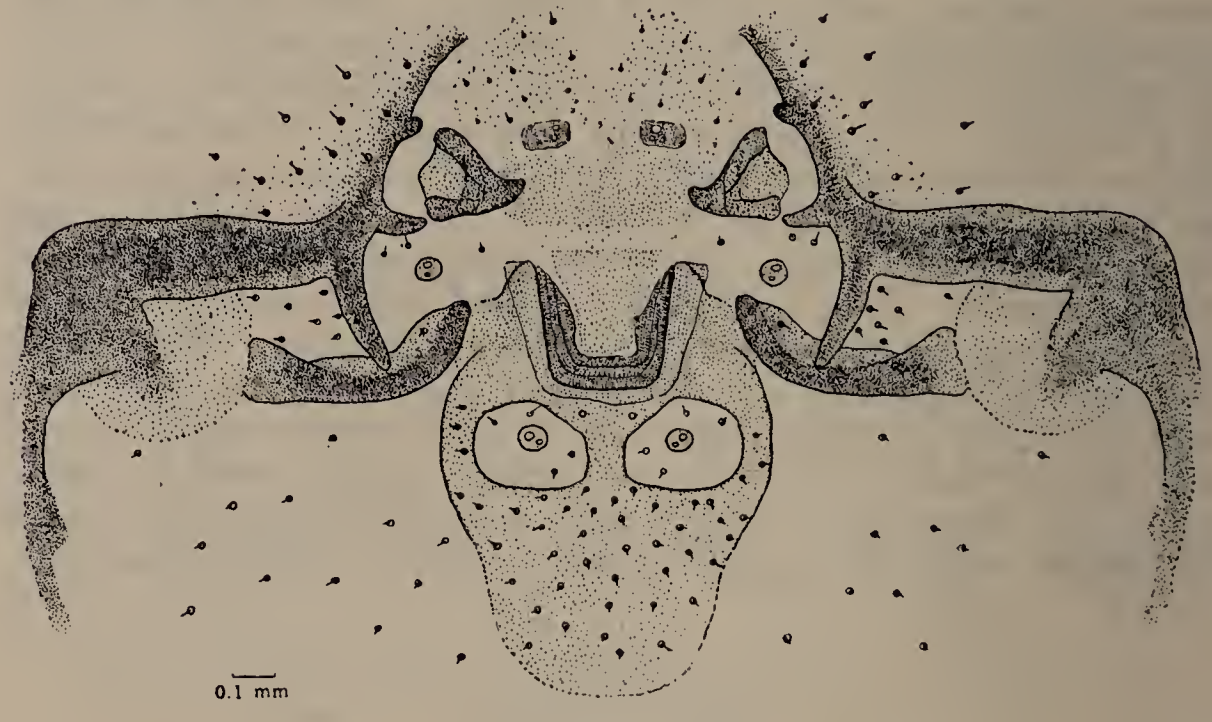

Fig. 13.
Allocamptus macrurus Drury.

The following species have been examined: *Ophion* spp., *Enicospilus ramidulus* L., *E. infuscatus* Tosq., *Allocamptus macrurus* Drury.

Janvier (1933) figures *Ophion luteus* L.

B. *Campoplegini.* (Fig. 14.)

The epistoma is developed to a greater or lesser extent on either side as a bar extending dorsally, the arch being incomplete. The anterior tentorial pits can usually be observed. The pleurostoma is usually present, but may be so reduced dorsally that the superior ramus only is apparent. The mandibles are rather small with curved, pointed blades. The inferior pleurostomal ramus is short, and below it there is usually a

short sclerotic projection for the support of the upper edge of the maxilla. The hypostoma is always well developed. The stipital scleromes are short and the maxillary scleromes are twisted. There is great variation in the shape of the labial sclerome. It may be complete or, more usually, incomplete ventrally; and it always bears lateral projections for the

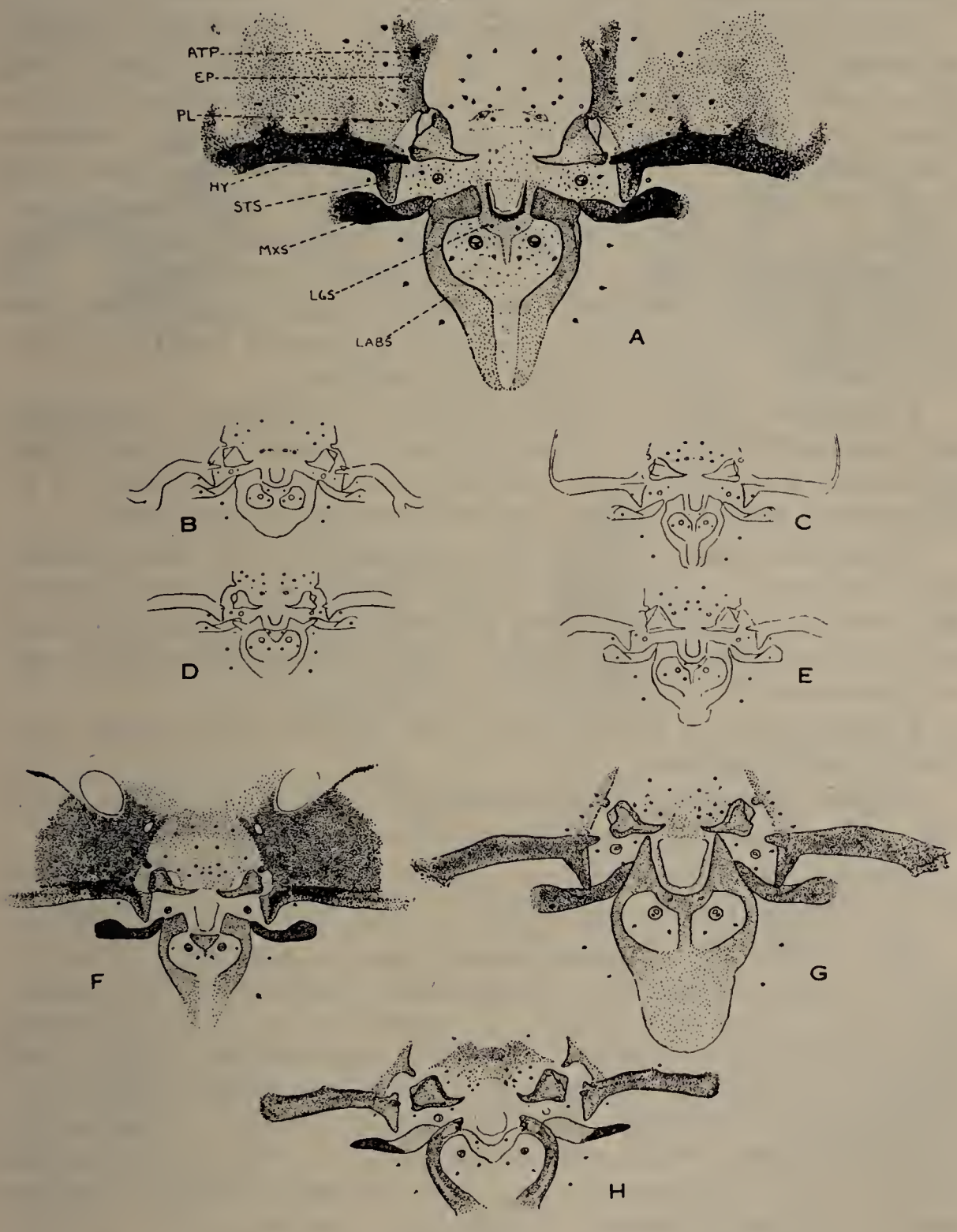

FIG. 14.

a, *Phobocampa confusa* Thoms.; b, *Dioctes exareolatus* Ratz.; c, *Anilasta tricolor* Ratz.; d, *Canidia exigua* Grav.; e, *Nemeritis bicingulata* Grav.; f, *Spudastica kriechbaumeri* Bridg.; g, *Campoplex cultrator* Grav.; h, *Charops obtusus* Morl.

articulation of the maxillary scleromes. The ligular sclerome is more or less strongly developed. The typical facial setae are present. The palps are small, with generally two sensoria. The labrum is pigmented to a varying extent and bears a number of sensillae and setae.

Except for certain distinct forms there appear to be no strong generic characters.

Charops is very peculiar and distinct. The labial sclerome is strongly curved laterally and incomplete ventrally. The dorsal ends are somewhat concave. Near the dorsal end, on either side, there is a lightly pigmented area on the sclerome and towards the ventral end a similar, more elongated area which contrasts strongly with the remainder of the sclerome, which is more heavily pigmented. The ligular sclerome also has a peculiar shape: its ventral arm is not present. The labrum is well pigmented, the shape of the pigmented area being rather characteristic. In other respects the facial rods and setae are typical in shape and position.

Campoplex has the labial sclerome enormously broadened and rounded ventrally. The ligular sclerome is equally well pigmented and sclerotized and its three arms are fused to it. This genus shows a strong resemblance to the Ophionini.

Spudastica has very heavily pigmented facial rods, almost black in parts. The genal regions lateral to the pleurostoma and dorsal to the hypostoma and extending to the antennae are also very heavily pigmented. The anterior tentorial pits are prominent.

Phobocampa is similar but with slightly less heavily pigmented genal regions.

Dioctes has the hypostoma sharply bent ventrally on either side. The labial sclerome is complete and broad ventrally.

Canidia has extremely long projections from the sides of the labial sclerome for the articulation of the maxillary scleromes.

The following species have been examined: *Charops obtusus* Morl., *Campoplex angustatus* Thoms., *C. consimilis* Schmied., *C. cultrator* Grav., *C. myrtillus* Desv., *C. adjunctus* Först., *C. obliteratus* Hlgr., *Sagaritis zonata* Grav., *S. punctata* Bridg., *S. postica* Bridg., *Casinaria morionella* Hlgr., *C. ischnogaster* Thoms., *C. claviventris* Hlgr., *Limnerium annulator* Zett., *Nemeritis bicingulata* Grav., *N. raphidiae* Kriechb., *N. crassiuscula* Grav., *N. croceipes* Marsh., *Phobocampa confusa* Thoms., *Spudastica kriechbaumeri* Bridg., *Omorgus mutabilis* Hlgr., *O. lugubrina* Hlgr., *Nepiera collector* Thoms., *Meloboris crassicornis* Grav., *Angitia cerophaga* Grav., *A. fenestralis* Hlgr., *A. plutellae* Vier., *Anilasta notata* Grav., *A. carbonaria* Ratz., *A. rufocincta* Thoms., *A. ebenina*

Grav., *A. tricolor* Ratz. (*Trophocampa vidua* Grav. of Morley), *Holocremnus ratzeburgi* Tschek, *Canidia exigua* Grav., *Dioctes exareolatus* Ratz., and several undetermined Campoplegini.

Morris, Cameron and Jepson (1937) figure *Holocremnus ratzeburgi* Tschek; Cameron (1938) figures *Angitia* sp.; Thorpe (1930) figures *Omorgus borealis* Zett., *O. ensator* Grav., *O. mutabilis* Hlgr., and *Eulimneria rufifemur* Thoms.; Paillot (1924) figures *Holocremnus* sp. and *Limnerium* sp.; Thorpe (1932) figures the primary larvae of *Omorgus mutabilis*

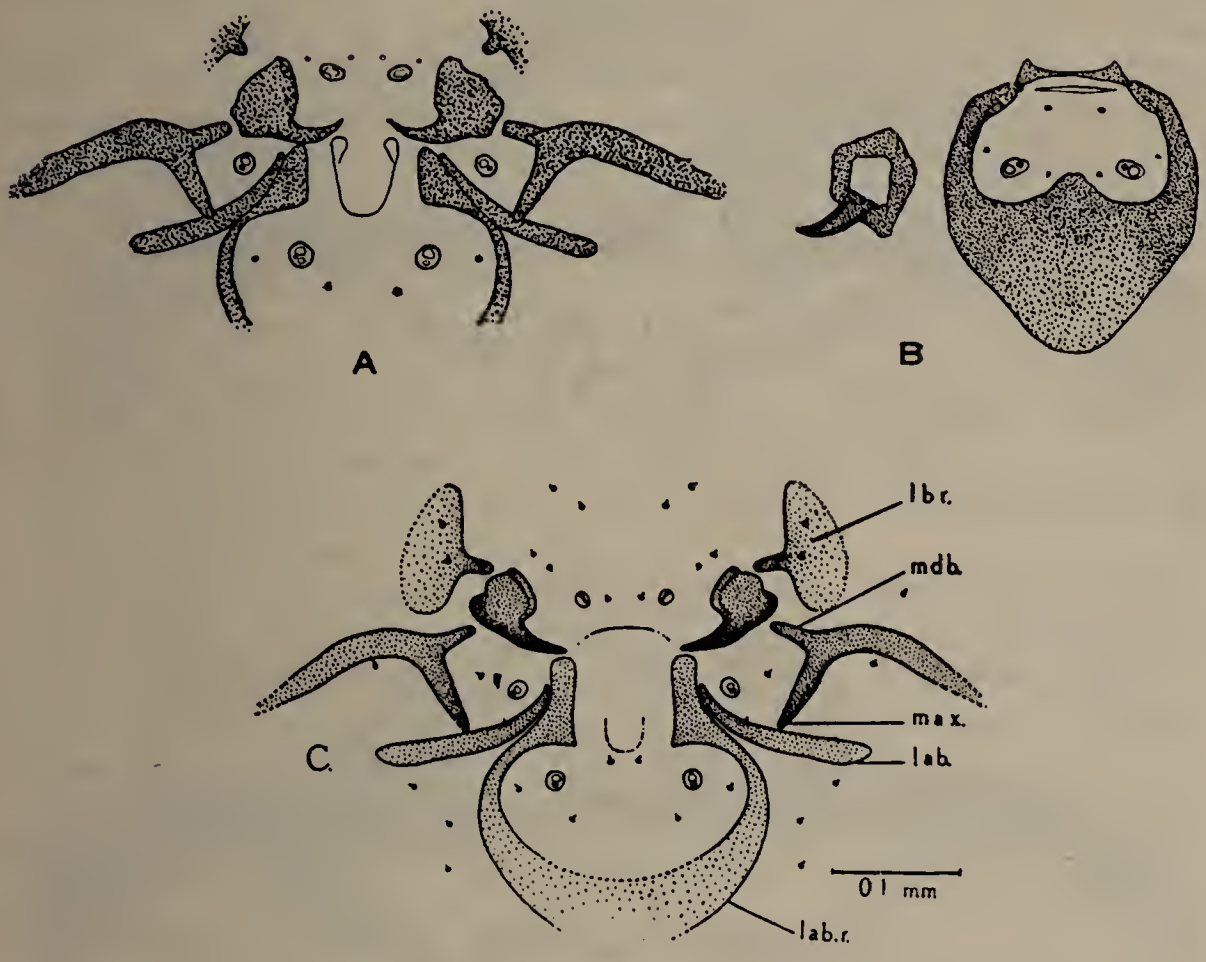

Fig. 15.

a, *Cremastus interruptor* Grav.; b, *Phorotrophus alcides* Wilk., labial sclerome and mandible;
c, *Pristomerus vulnerator* Panz. (after Rosenberg 1934).

Hlgr., and *Eulimneria rufifemur* Thoms.; Thompson and Parker (1930) figure *Eulimneria crassifemur* Thoms.; Goidanich (1931) figures *Limnerium alkae* Ell. et Sachtl.; Paillot (1924) figures *Holocremnus incrassator* Hlgr.; Graf (1917) figures *Campoplex phthorimaeae* Cush.

C. Cremastini. (Fig. 15, a, c.)

These are very closely related to the Campoplegini.

The epistoma and pleurostoma are lightly pigmented and are only visible in the immediate neighbourhood of the superior

pleurostomal rami. The inferior rami are long, the mandibles are of the typical Campoplegid form. The maxillary scleromes are slender and not twisted, in which respect they differ from the Campoplegids. The labial sclerome is incomplete ventrally and broadened at its dorsal ends. The typical facial setae are present. The labrum bears a pair of sensillae. Otherwise the facial rods are as in the Campoplegini.

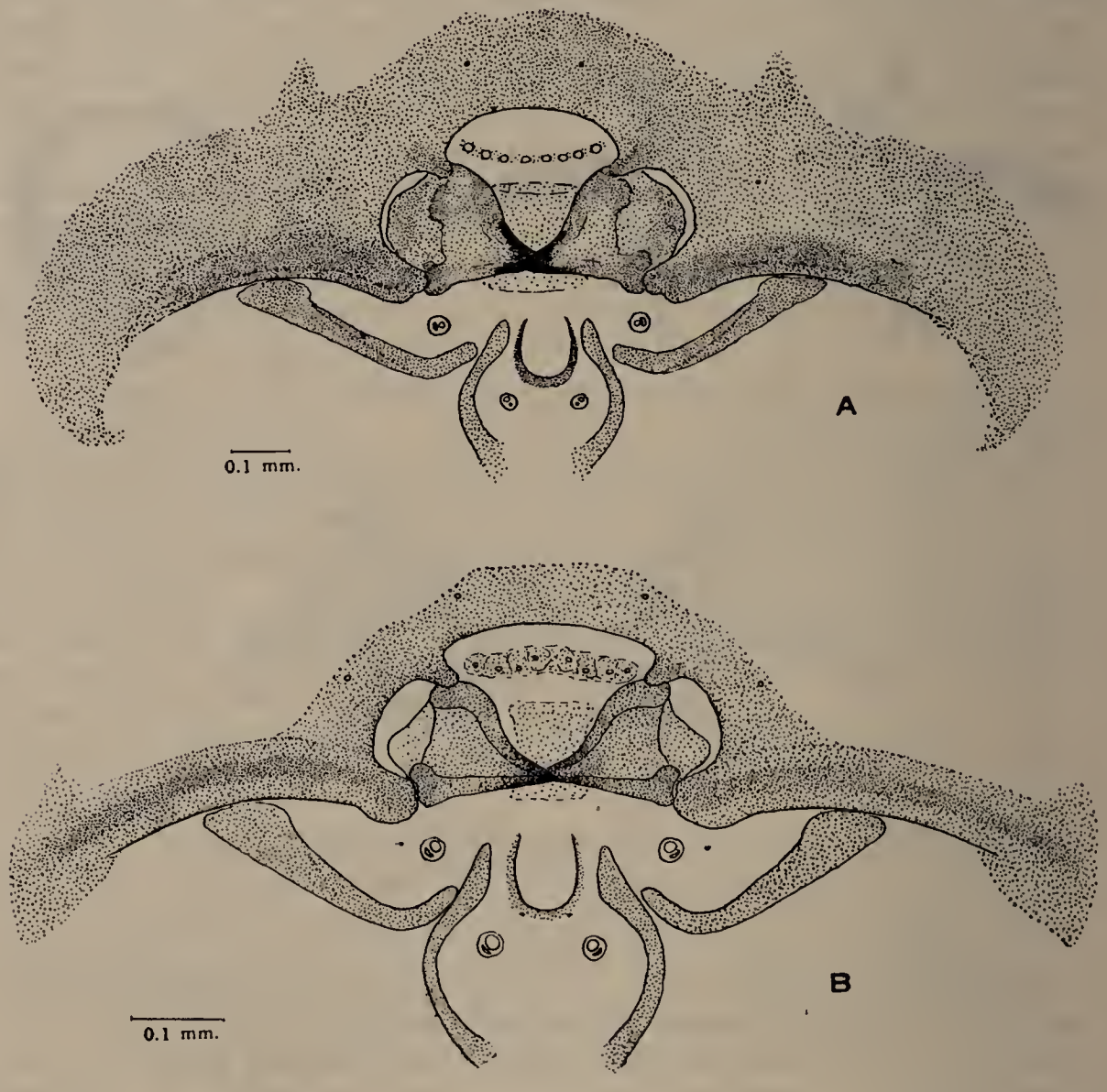

Fig. 16.

a, *Aphanistes armatus* Wesm.; b, *Blaptocampus nigricornis* Wesm.

The species examined were *Cremastus geminus* Grav., and *C. interruptor* Grav.

Thorpe (1930) figures *Cremastus interruptor* Grav., and (1932) its primary larva. Bradley and Burgess (1934) figure *Cremastus flavoorbitalis* Cam. Rosenberg (1934), and Goidanich (1931) figure *Pristomerus vulnerator* Panz.

5. Subfamily Anomalinae. (Fig. 16.) Anomalini.

The epistomal arch and pleurostoma are complete, thick and well-developed; the inferior pleurostomal ramus is large and blunt. The mandibles are large, with sharply pointed and well-pigmented blades. The hypostoma extends laterally, on either side, as a long, thick, slightly curved bar, pigmented down its middle, and ending in an enlarged sclerotic patch. In some, the genal areas lateral to the pleurostoma and dorsal to the hypostoma are also well sclerotized and pigmented. The pleurostoma and the hypostoma each bear a pair of small apertures in the cuticle which correspond to facial setae. The stipital scleromes are absent. The maxillary scleromes extend from the hypostoma to the labial sclerome. At the hypostomal end each is broadened, and at the end nearest the labial sclerome each is sharply bent upwards. The labial sclerome is incomplete ventrally. The edges of the orifice of the silk duct are somewhat pigmented. The labrum bears a single transverse row of eight sensillae; and below, beneath the tips of the mandibles, a roughly rectangular pigmented area with concave sides. The maxillary and labial palps bear two sensoria. The facial setae are extremely reduced.

The writer has discovered no means of distinguishing the various genera from each other.

The following species have been examined: *Schizoloma amicta* Fab., *Agrypon variitarsum* Wesm., *A. flaveolatum* Grav., *Labrorychus tenuitarsus* Grav., *L. flexorius* Thunb., *Anomalon latro* Schr., *Aphanistes armatus* Wesm., *Blaptocampus nigricornis* Wesm.

Rosenberg (1934) figures *Trichomma enecator* Rossi, and Ratzeburg (1844) figures *Anomalon* sp.

6. Subfamily Bassinae. (Fig. 17.) Bassini.

The larvae of this tribe are parasites of hoverflies, and the mouth-parts show extreme specialisation. On larval characters there is no apparent relationship with any other group.

The labial sclerome is the most striking feature; it is large, thick and well developed, and is strongly pointed ventrally. The pleurostoma may be seen in some forms as a very lightly pigmented bar, with the rami as short projections on either end, on either side dorsal to the labial sclerome. The mandibles are unsclerotized and unpigmented and are generally more apparent in *Homocidus* than in *Bassus*. The facial setae are very much reduced. The maxillary and labial palps are irregular in shape and bear a varying number of sensoria.

The following species have been examined: *Bassus tetragonus* Thunb., *B. strigator* Fab., *B. laetatorius* Fab., *Homocidus sundevalli* Hlgr., *H. tarsatorius* Panz.

Salt (1936) has written a brief note on *Bassus laetatorius* Fab.[1]

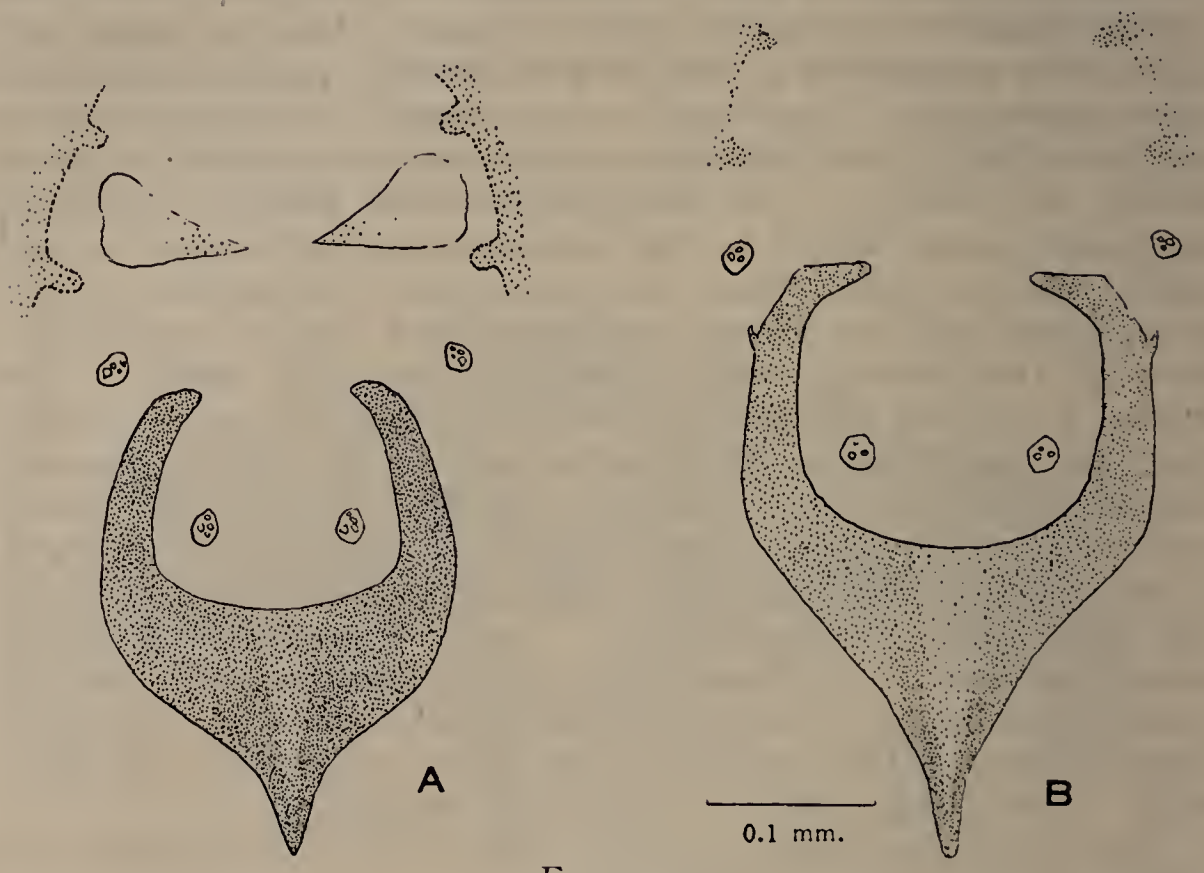

Fig. 17.

a, *Homocidus tarsatorius* Panz.; b, *Bassus tetragonus* Thunb.

7. Subfamily Metopiinae. (Fig. 18.)

The larvae of this subfamily closely resemble those of the Anomalinae.

Key to tribes.

Epistomal arch complete and well pigmented ..... *A. Metopiini.*
Epistomal arch incomplete or not well pigmented and sclerotized ..... *B. Exochini.*

A. Metopiini. (Fig. 18, b.)

The epistomal arch is complete, the pigmentation extending dorsally for some distance. The pleurostoma is likewise well developed. The hypostoma extends laterally on either side and is strongly pigmented down its mid-line; it ends in a large sclerotic patch. A considerable area of the genal regions lateral to the pleurostoma and dorsal to the hypostoma is

[1] Larvae of the following Bassinae have been described and figured in a paper published since the receipt of the present work: *Bassus laetatorius* Fab., *Homocidus tarsatorius* Panz. and *Promethus monticola* Sey.; a single figure is given to represent the condition in *Homocidus signatus* Grav., *H. nigritarsis* Grav. and *H. pictus* Grav. [Scott, E. I. 1939. An account of the developmental stages of some aphidophagous Syrphidae (Dipt.) and their parasites (Hymenopt.). *Ann. appl. Biol.*, **26**: 509-32, 6 pls.]. This note does not imply that a search has been made of the most recent literature (G.J.K.).

sclerotized and pigmented to an extent only slightly less than that of the pleurostoma and hypostoma themselves. In some specimens this area is not sclerotized. The mandibles are large, with strongly pigmented blades. The maxillary sclerome is broadened at its hypostomal end and bent sharply upwards at its opposite end; it is attached to the anterior end of the hypostoma by a sclerotic patch extending from its posterior

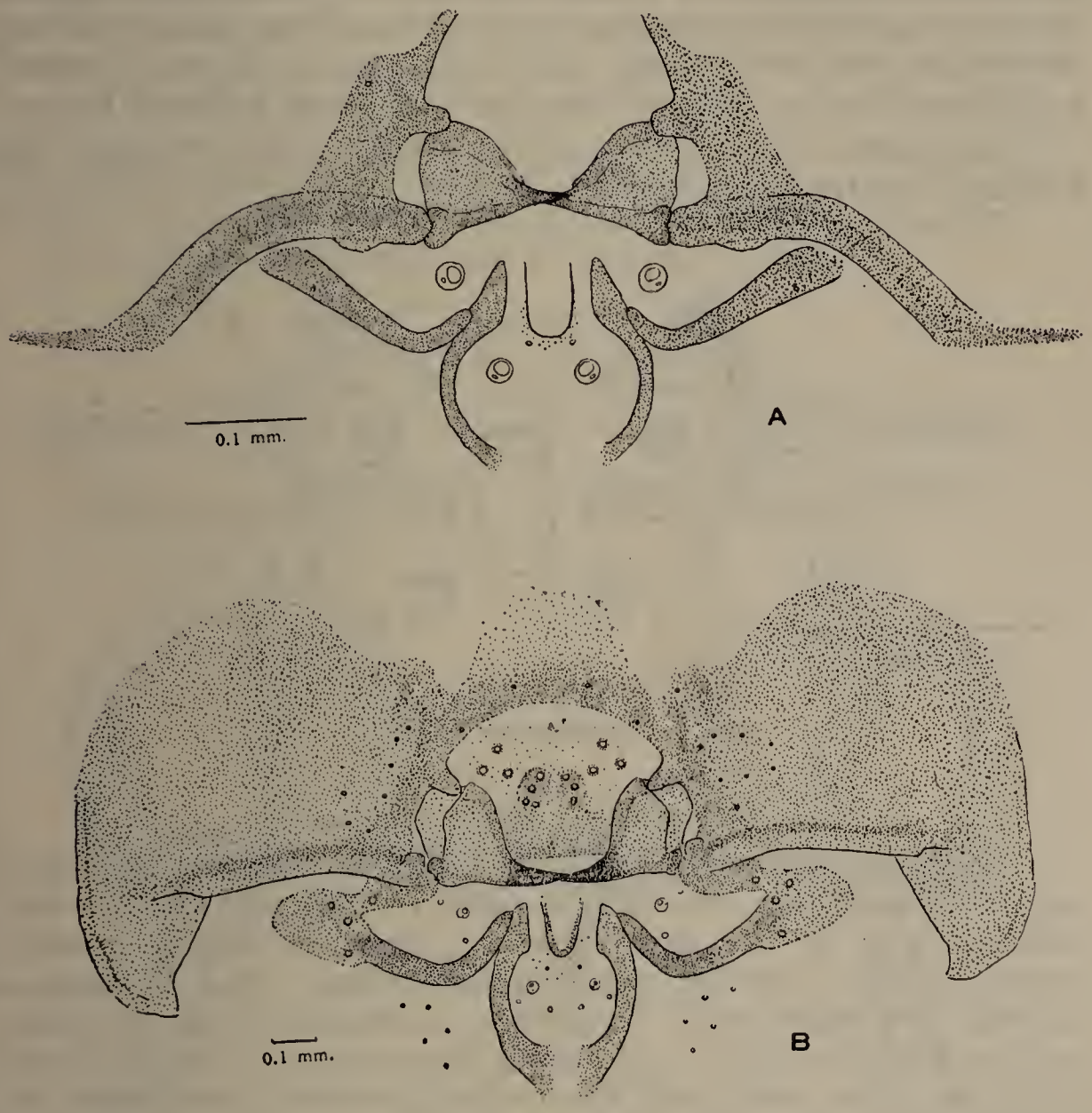

Fig. 18.

a, *Triclistus podagricus* Grav.; b, *Metopius anxius* Wesm.

end, which may represent the stipital sclerome, although it is doubtful if it does. Otherwise the stipital sclerome is not developed. The labial sclerome is broken ventrally and is similar in shape to that of the previous Anomalini group. The edges of the orifice of the silk duct are pigmented. The labrum is somewhat pigmented. In its centre there are two pigmented areas each with three sensillae, and lateral to each of these

patches are a further three sensillae. The maxillary and labial palps bear two, or sometimes three, sensoria.

A number of facial setae and sensillae are present. Each maxillary sclerome bears three sensillae at the hypostomal end, and a fourth to the sclerotic patch which joins it to the hypostoma. The typical three pairs of setae are present on the prementum, and there are two pairs on the maxillary stipites. There are two pairs, on either side, on the postmentum lateral to the labial sclerome, two pairs on the epistoma, and a varying number on the pleurostoma and on the genal regions immediately lateral to it. All the setae are very much reduced in size.

The species examined were *Metopius anxius* Wesm. and *Peltocarus* (*Metopius*) *dentatus* Fab.

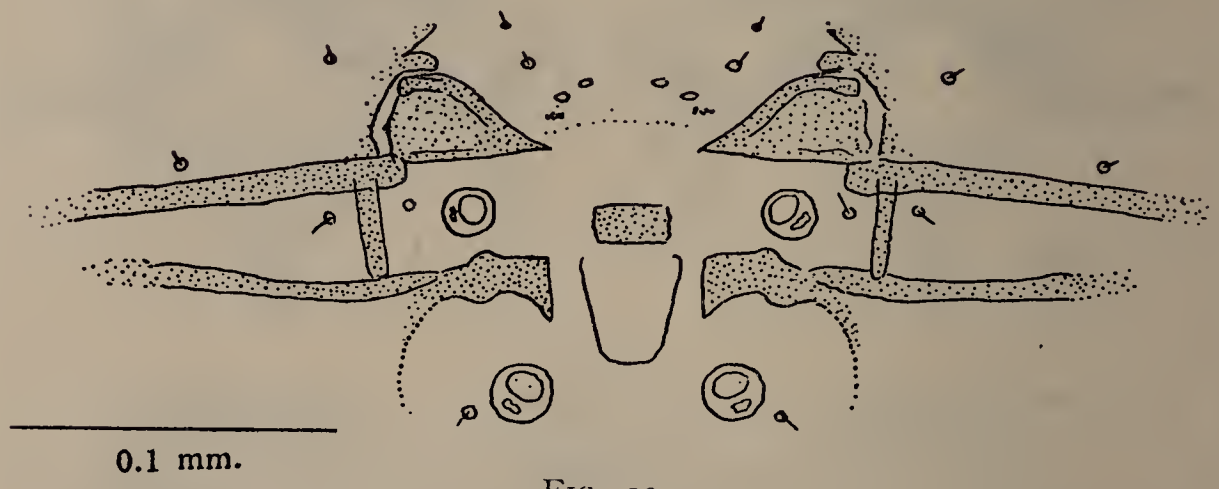

Fig. 19.
Thersilochus sp.

B. Exochini. (Fig. 18, a.)

This tribe differs from the Metopiini in that the epistomal arch is incomplete. The lateral parts of the epistoma are well developed, as is the pleurostoma. A single seta is present lateral to each superior pleurostomal ramus. The hypostoma is thick and pigmented; it extends laterally, curves ventrally, and tapers to a point. A small prominence from its lower edge, on either side near the ramus, probably represents the stipital sclerome. The maxillary scleromes extend from the hypostoma to the labial sclerome, near which they are sharply bent upwards as in the Anomalini. The labial sclerome is incomplete ventrally and is identical with that of the previous tribe. The facial setae are extremely reduced, and the maxillary and labial palps bear two sensoria. The mandibles are large, with pointed and pigmented blades.

Unfortunately all the specimens examined had the labral area damaged, so this was not included in the figure.

The species examined was *Triclistus podagricus* Grav.

8. Subfamily Porizoninae. (Fig. 19.) Porizonini.

The one species of this tribe examined belongs to the genus *Thersilochus*. The facial rods are very lightly sclerotized and pigmented and their structure is difficult to elucidate. The pleurostoma and epistoma appear as a slightly curved bar on either side. The stipital and maxillary scleromes are straight and moderately well developed. The mandibles are short and sharply pointed. The dorsal ends of the labial sclerome are the only parts visible, but the structure here is very obscure. Above the orifice of the silk duct there is a short transverse bar. The facial setae are reduced to a pair on the prementum and a pair on each maxilla, and two pairs on the genal regions. The labrum bears five pairs of sensillae. The maxillary and labial palps each have one large and one small sensorium.

The species examined was a *Thersilochus* sp.

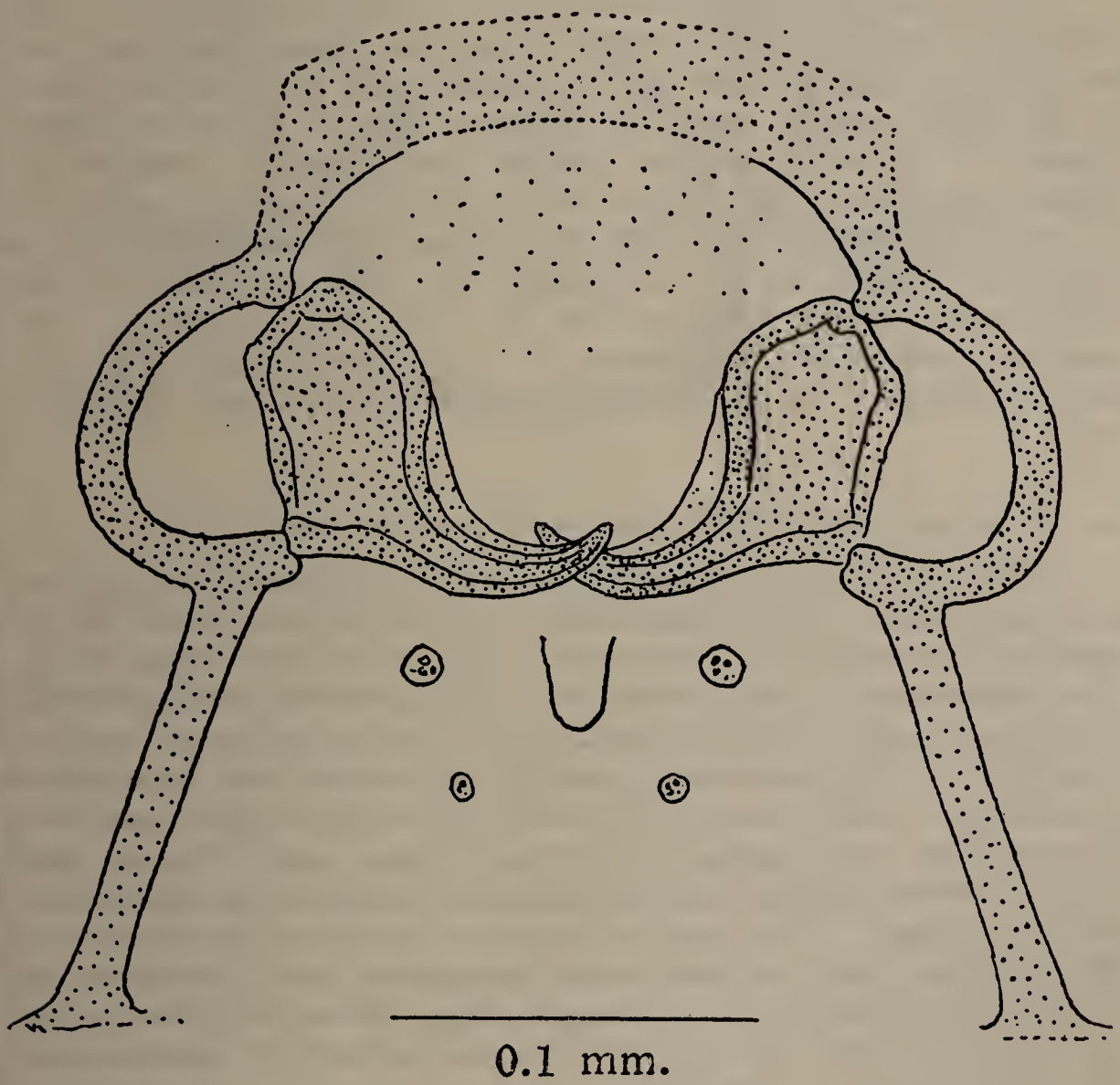

Fig. 20.

Orthopelma mediator Thunb.

Cushman (1916) figures *Thersilochus conotracheli* Riley, and Silvestri (1917) figures *Thersilochus coeliodicola* Silvestri.

9. Subfamily Orthopelminae. (Fig. 20.) Orthopelmini.

This tribe, placed by Morley in the subfamily Cryptinae, and by Schmiedeknecht in the subfamily Ophioninae in the tribe Porizonini, very closely resembles, in larval characters, the Ichneumoninae.

The epistomal arch is complete. The pleurostoma is narrow and strongly curved on either side. The labial, maxillary, and stipital scleromes are absent. The hypostoma extends ventrally and somewhat laterally as a straight bar on either side. The mandibles are strongly curved and are ridged on the upper edge of the blade (Fig. 4, p). Each palp bears about five sensoria.

The strongly-curved pleurostoma and the shape of the mandibles set this genus apart from the Ichneumoninae, but the general arrangement of the facial rods and the structure of the palps would seem to indicate that it is very closely related to them. Perhaps similar larval habits resulted in similar specialisations of the facial rods. Nothing seems to be recorded of the habits of the larva of *Orthopelma*. The absence of teeth on the mandibles and the reduction of the facial setae would indicate that it is an endoparasite. The common species of *Orthopelma, O. mediator* Thunb. (Fig. 20), was examined: it is parasitic on the gall-wasp, *Rhodites rosae* L.

10. Subfamily Mesochorinae. (Fig. 21.). Mesochorini.

The facial rods, in general, are only moderately sclerotized and pigmented. The pleurostoma and the lateral parts of the epistoma are fairly well defined. The rami are rather long. The hypostoma is not sclerotized or pigmented lateral to the stipital sclerome in *Mesochorus,* but extends laterally, curving ventrally, in *Astiphrommus,* and is sclerotized and pigmented to a degree equal to that of the other facial rods. The mandibles are peculiar, each consisting of a ring-like basal portion and a long pointed blade, both of which are moderately sclerotized and pigmented. The intervening area, between the blade and the ring-like basal portion, is not sclerotized or pigmented. It is difficult to conjecture the exact mode of use of these structures (Fig. 4, t). Each maxillary sclerome is twisted near its anterior end. The labial sclerome is narrow and is complete ventrally. The orifice of the silk duct is very long and extends well down into the prementum. The maxillary and labial palps each bear two sensoria. With the exception of

one on each maxillary sclerome, the facial setae are very much reduced. There is a pair of sensillae on the labrum, which is not pigmented. There is a patch of spines on the end of the body. A similar patch is found in the Bassini.

The following species have been examined: *Mesochorus sylvarum* Curt., *M. fulgurans* Curt., *M. gracilentus* Brischke, *M. pectoralis* Ratz., *M. confusus* Hlgr., *Astiphrommus strenuus* Hlgr.

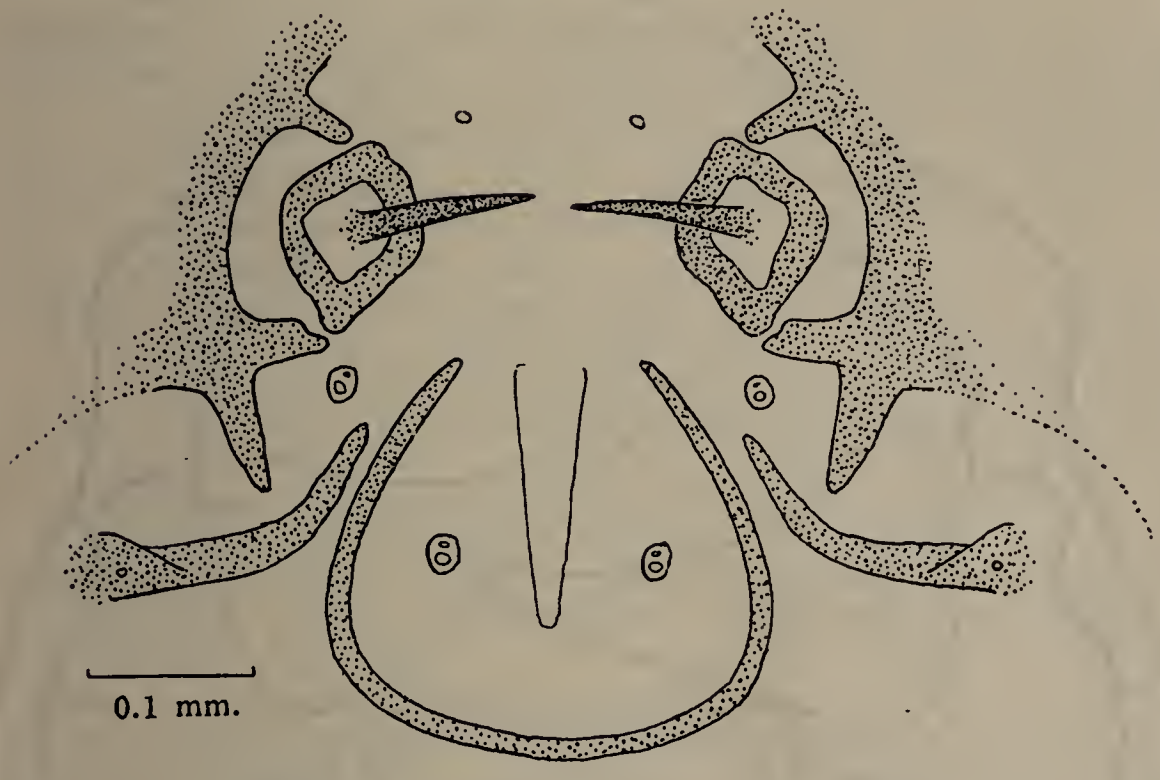

Fig. 21.
Mesochorus fulgurans Curt.

11. Subfamily Acoenitinae. (Fig. 15.) Acoenitini.

One specimen of one species of this tribe was examined: *Phorotrophus alcides* Wilk., and this was somewhat damaged.

The mandibles are very similar to those of *Mesochorus* except that the blades are more curved. The epistoma, pleurostoma and hypostoma are not well sclerotized or pigmented and resemble the corresponding structures of *Mesochorus*. The stipital and maxillary scleromes were missing in the specimen examined, probably through accident. The labial sclerome is very broad and bluntly pointed ventrally; a short sclerotic bar extends across the upper edge of the preoral cavity between the ends of the labial sclerome. The facial setae are very much reduced.

Baumann (1933) gives a figure of *Coleocentrus excitator* Poda which appears to be considerably different from *Phorotrophus*.

12. Subfamily Collyriinae. (Fig. 22.) Collyriini.

This is totally different from any other Ichneumonid. Salt (1931) describes and figures the larva of *Collyria calcitrator* Grav., and the following description and the figure are taken from his work. 'The head, like the rest of the body, is extremely delicate and without any sclerotized areas. There are fleshy lobes about the mouth-opening which probably repre-

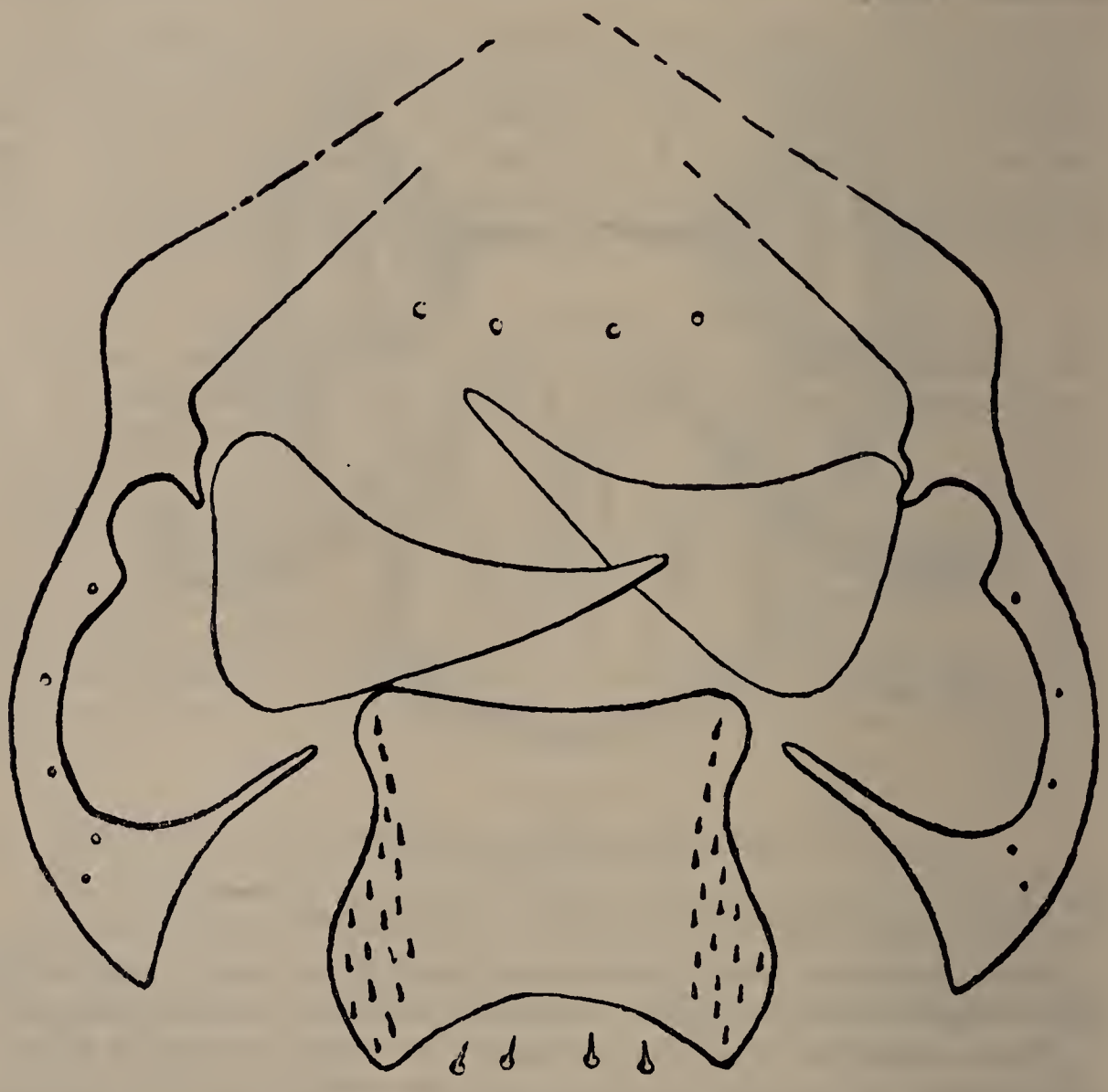

Fig. 22.
Collyria calcitrator Grav. (after Salt 1931).

sent the labral, maxillary and labial areas, but there are no hardened or darkened parts at all. Careful staining, however, shows that the mandibles and some of the usual facial rods are represented but not well developed. A large plate underlies the labial area, the mandibular struts may be clearly distinguished, and there are vague sclerotic areas in the labral region, but all the parts are so poorly developed that it is difficult to homologise them.'

13. Subfamily Cryptinae. (Figs. 23, 24, 25, 26, 27, 28.)

Unlike the previous twelve subfamilies, the Cryptinae and Tryphoninae are ectoparasites and, except in the Cteniscini, the larvae have teeth on the mandibles.

Key to tribes.

1. Mandibles with single row of teeth situated on upper edge of blade ..... 2.
   Mandibles with two rows of teeth, lower row sometimes very much reduced ..... 5.
2. Epistoma moderately or well developed ..... 3.
   Epistoma not sclerotized or pigmented; mandibles with long curved blades with a single row of long teeth reaching to tip of blade (Fig. 4, a); labral sclerome apparently absent ..... *J. Adelognathini.*
3. Mandibles with blades long, teeth not reaching to tip (Fig. 4, e); facial setae very long and well developed ..... *A. Polysphinctini.*
   Mandibles shorter, powerful (Fig. 4, b); facial setae short ..... 4.
4. Posterior end of hypostoma with a slight dorsal bend; shape of epistoma ill-defined; part of inferior pleurostomal ramus extending anteriorly as a bar on which the mandible rests ..... *E. Odontomerini.*
   Posterior end of hypostoma not with a slight dorsal bend; epistoma fairly well defined ..... *D. Xylonomini.*
5. Mandibles with blades not curved, teeth on upper and lower edges equal in size and number (Fig. 4, c, d) ..... 6.
   Mandibles with blades straight or curved, row of teeth on upper edge well developed, lower row usually very much reduced and situated on outside of blade ..... 7.
6. Labial sclerome sharply pointed ventrally ..... *B. Rhyssini.*
   Labial sclerome not sharply pointed ventrally ..... *C. Ephialtini.*
7. Mandibles with blades moderately long, teeth variously developed (Fig. 4, f, i, k); hypostoma curving ventrally to below level of maxillary scleromes ..... 8.
   Mandibles with blades long, lower row of teeth very much reduced (Fig. 4, h); hypostoma not curving ventrally to below level of maxillary scleromes ..... *F. Sphecophagini.*
8. Facial rods thicker; epistoma usually moderately pigmented medially ..... *I. Cryptini.*
   Facial rods narrower; epistoma usually not or lightly pigmented medially ..... *G. Phygadeuonini.*

This subfamily is, on the larval characters, obviously related to the Tryphoninae, and the various tribes are related to each other to a greater or lesser extent. The Polysphinctini are very distinct, but are most nearly related to the Rhyssini. The Rhyssini and Ephialtini are more closely related to each other than to the remaining tribes. The Xylonomini and Odontomerini are so closely related to each other as to be almost indistinguishable. The Phygadeuonini and Cryptini are likewise very closely related. These two groups of tribes are closely related to each other through the Sphecophagini. The Adelognathini are quite distinct.

A. Polysphinctini. (Fig. 23.)

The larvae of this distinct group are ectoparasites of spiders.

The epistomal arch is not present. On either side the epistoma extends dorsally as a bar, broadened basally where it meets the pleurostoma and well pigmented at its dorsal ends. The pleurostoma is broad, broadest where it meets the hypostoma: the inferior ramus is well pigmented. The hypostoma extends laterally and somewhat ventrally on either side as a long, narrow, slightly curved bar; it is well pigmented, particularly towards its dorsal edge. The stipital sclerome is also long, narrow, and well pigmented, and extends at right angles

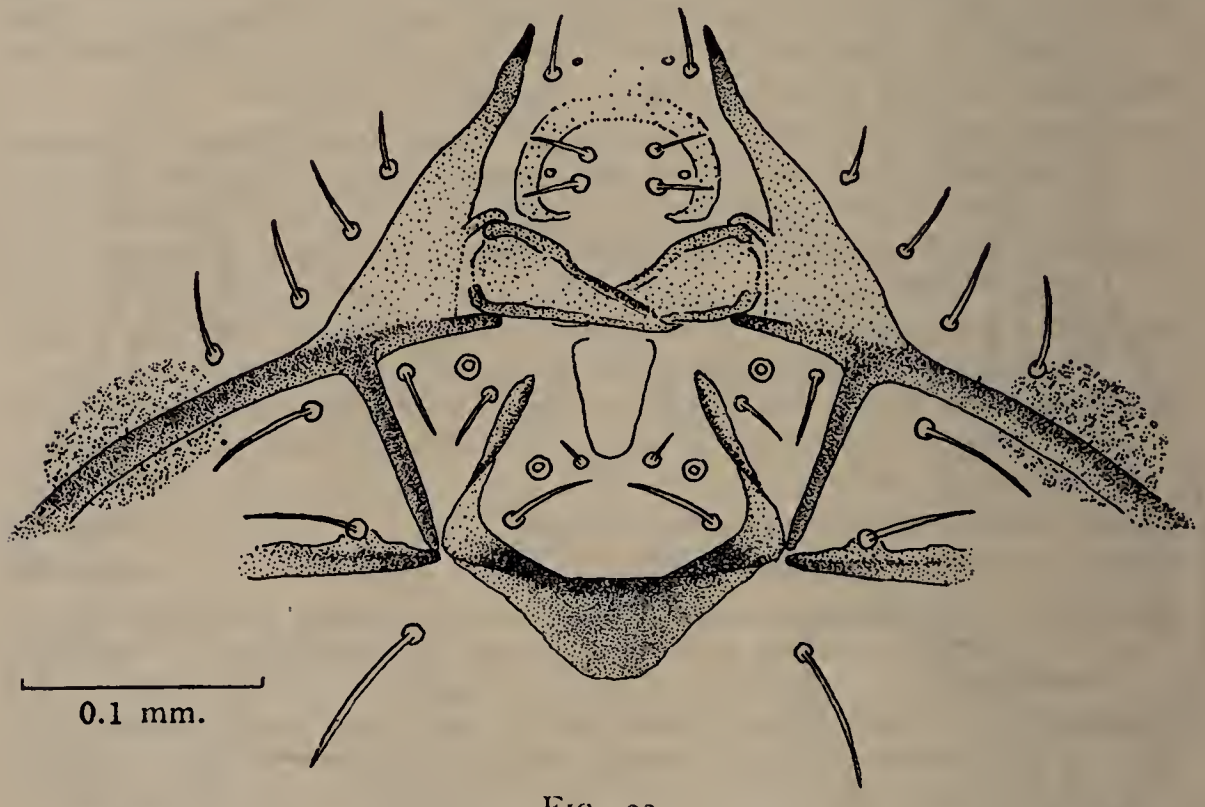

Fig. 23.
Acrodactyla degener Hal.

to the hypostoma to touch the labial sclerome. Each maxillary sclerome is short and extends laterally, bearing a single seta. The labial sclerome is roughly U-shaped; the upper parts of the lateral arms and the basal portion appear to be twisted in relation to the remainder; ventrally it is bluntly pointed and heavily pigmented. The facial setae are typical in number and position but are enormously developed in size and length: no other Ichneumonid approaches this great development of the setae. The maxillary and labial palps each bears a single sensorium, another rather characteristic feature. The labral sclerome is broad but not strongly developed. The mandibles are toothed on the upper edge only and are curved at the tips (Fig. 4, e).

Beneath the hypostoma on either side there is a peculiar ornamentation of the cuticle. The long setae are present all over the body; and on the centre of each segment, down the back of the larva, there is a small area set with sclerotized spines or hooks which are pigmented to a varying extent.

The species examined was *Acrodactyla degener* Hal.

B. Rhyssini. (Fig. 24.)

The epistomal arch is complete but not heavily pigmented. The pleurostoma is better defined and becomes broadened ventrally; the rami are long. The mandibles have straight,

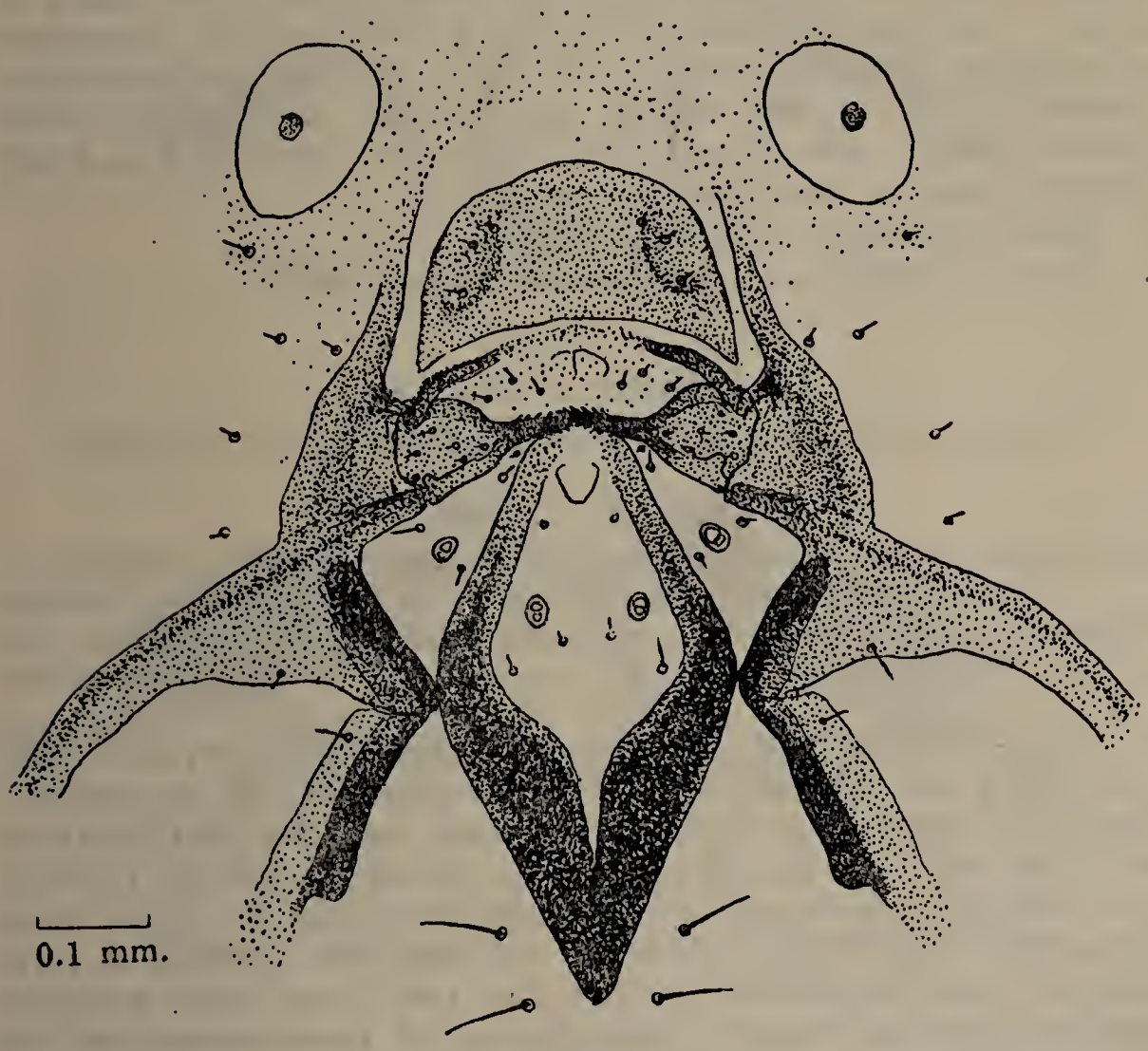

Fig. 24.
Rhyssa sp.

heavily pigmented blades which are toothed on both edges (Fig. 4, c). The hypostoma extends laterally, and somewhat ventrally on either side and is rather curved. Beside the stipital sclerome it is much broadened to meet that structure, which is heavily pigmented and touches the lateral edges of the labial sclerome. The maxillary scleromes extend laterally, and are strongly inflected ventrally, from the ends of the

stipital scleromes to which they are fused; the ventral border, extending about halfway down the sclerome, is heavily pigmented. The labial sclerome has a characteristic rhomboidal shape. It is elongate dorso-ventrally and very strongly pointed ventrally; the ventral part is thick-walled and there is a deep incision on the inside corresponding to the point on the outside. The ventral, and part of the lateral, walls are strongly pigmented. The facial setae are typical in number and position and are moderately long; the two on each side lateral to the labial sclerome are much longer than the rest. The palps bear two pits. The lower portion of the labrum (the labrum proper) overlies the mandibles and bears about ten pairs of setae. Its upper edge is strongly sclerotized and pigmented to form the labral sclerome: this pigmentation is best developed laterally. The clypeal area is in the shape of a roughly semicircular plate, concave ventrally, and well sclerotized and pigmented, bearing three pairs of setae.

One *Rhyssa* sp. was examined.

Riley (1888) figures *Thalessa lunator* Fab.

C. Ephialtini. (Fig. 25.)

This tribe shows a definite relationship to the Rhyssini.

Key to genera.

Hypostoma with enlargement lateral to pleurostoma; labial sclerome not lobed; multiparasites pupating within the host cocoon ..... *Iseropus.*

Hypostoma not enlarged; labial sclerome frequently lobed ventrally; solitary parasites ..... *Ephialtes, Delomerista.*

The epistoma and pleurostoma extend dorsally, on either side, as a well-defined bar; the epistomal arch is incomplete. The hypostoma is straight and extends laterally and ventrally on either side. In *Iseropus* it is less strongly ventrally directed and, immediately lateral to the stipital sclerome, it is very much enlarged. The stipital scleromes are long and directed at right angles to the hypostoma so that they touch the labial sclerome at their ventral ends. The degree of development of the maxillary scleromes appears to vary in different species. The sclerome extends on either side, from a point near where the stipital sclerome reaches the labial sclerome, laterally and ventrally, or perhaps directly laterally, or sometimes laterally and dorsally. Its anterior end is always the more strongly pigmented. The form of the labial sclerome is characteristic in certain species. The lateral arms are long and strongly curved inwards dorsally. Ventrally the sclerome is unbroken and its ventral edge is produced into a number of lobes. The number and size of the lobes varies from species to species,

and may prove to have some specific value. The facial setae are typical in number and position. The palps bear two sensoria. The labrum bears six pairs of setae; it is moderately pigmented, the labral sclerome more strongly so. The mandibles resemble those of *Rhyssa* (Fig. 4, d).

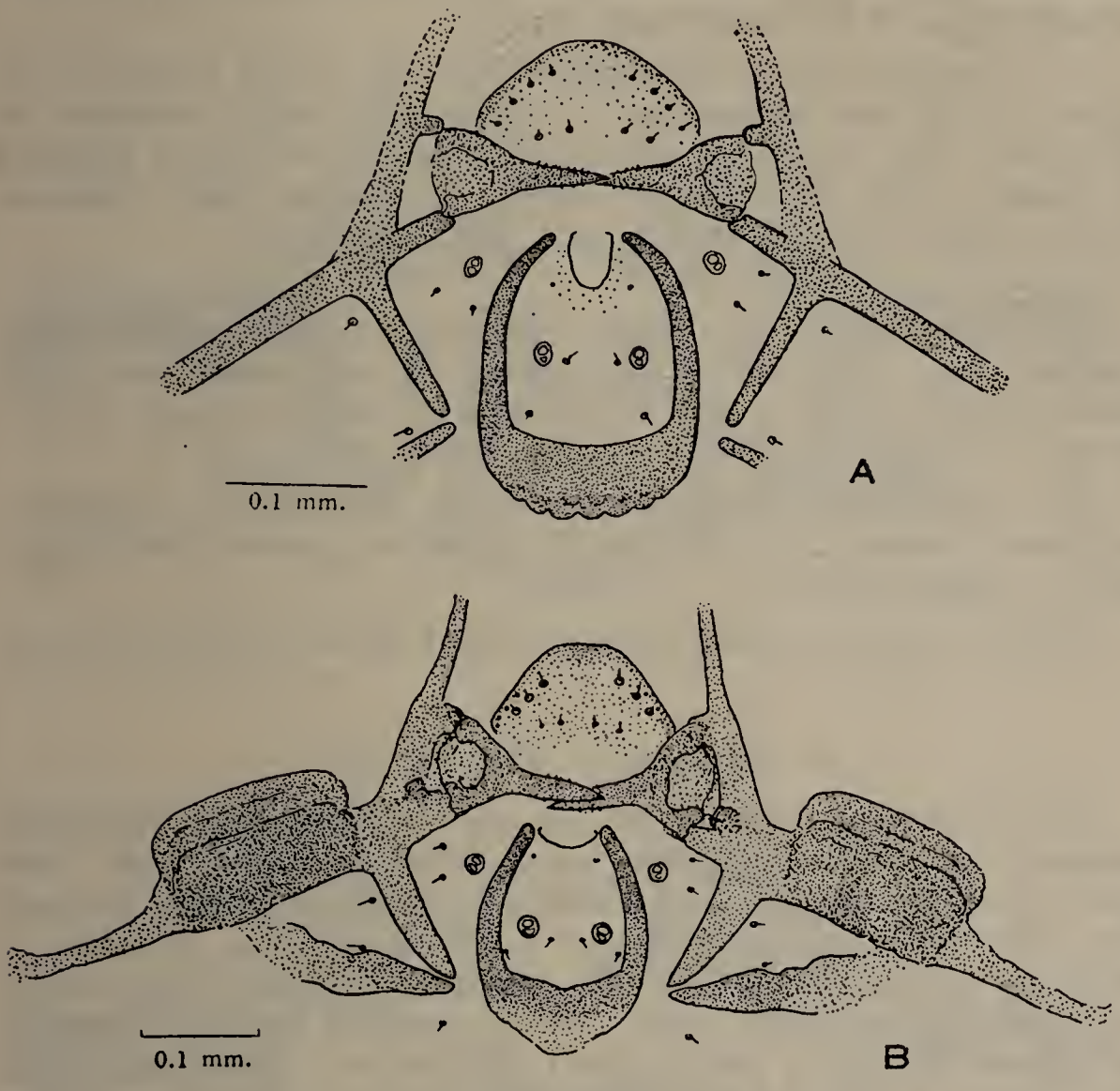

Fig. 25.
a, *Ephialtes extensor* Tasch.; b, *Iseropus graminellae* Hlgr.

Ephialtes detritus Hlgr. appears to have the lobes of the labial sclerome remarkably well developed; and the maxillary scleromes extending laterally to the ends of the hypostoma (figured by Salt, 1931).

E. ruficollis Grav. appears to have the labial sclerome more rounded, and the lobes moderately produced. The maxillary scleromes are very short (figured by Thorpe, 1930).

E. brevicornis Grav. also appears to have the labial sclerome rounded. The lobes are less developed than in *ruficollis*. The maxillary scleromes seem to be well developed and

to extend laterally and somewhat dorsally (figured by Thorpe, 1930). *E. manifestator* L. appears rather similar (figured by Baumann, 1933).

E. extensor Tasch. has the lobes of the labial sclerome short and more numerous. As in *ruficollis* the maxillary scleromes are short and extend laterally and ventrally (Fig. 25, a; also figured by Rosenberg, 1934).

E. pomorum Ratz. appears to have the labial sclerome not lobed at all, but resembling in shape the labial sclerome of *Iseropus*. The maxillary scleromes are well developed (figured by Imms, 1918, and Speyer, 1926). *E. nucum* Ratz. appears rather similar (figured by Silvestri, 1922 and 1933).

The two species of *Iseropus* examined could not be distinguished from each other. As previously mentioned, the enormous enlargement of the hypostoma is characteristic of this genus. The labial sclerome is not lobed.

The following species have been examined: *Ephialtes extensor* Tasch., *E. dux* Tschek, *Iseropus graminellae* Hlgr., and *I. satanas* Morl.

Morris, Cameron and Jepson (1937) figure *Delomerista* sp.

D. Xylonomini. (Fig. 26, a.)

The epistomal arch is incomplete, the epistoma extending dorsally as a short, slightly curved bar on either side from the top of the pleurostoma, which is moderately well defined. The inferior ramus consists of two struts, one articulating with the back of the mandible, and one with the underneath, on which the mandible rests. The hypostoma extends laterally, on either side, as a rather short, broad bar, ending abruptly. The stipital scleromes are long; the maxillary scleromes somewhat twisted. The labial sclerome is U-shaped, wider basally, with the lateral portions folded in relation to the ventral portion. The edges of the orifice of the silk duct are produced and pigmented. The typical facial setae are present; the palps bear two sensoria. The labral sclerome is strongly developed, its ends resting on the mandibles which are large and powerful, with short blades armed with a row of large teeth on the upper edge (Fig. 4, b). The labrum bears four pairs of large setae and a number of smaller sensillae.

The species examined was *Xylonomus precatorius* Fab. Chrystal and Skinner (1931) figure *X. brachylabris* Kriechb. and state that they can find no difference between it and *X. irrigator* Fab.

E. Odontomerini. (Fig. 26, b.)

There is very little to distinguish these from the Xylonomini. The posterior ends of the hypostoma have a slight dorsal bend; the epistoma is not so well defined, and the inferior pleurostomal ramus extends as a bar below the mandible.

Fig. 26.

a, *Xylonomus precatorius* Fab.; b, *Ischnoceros rusticus* Frc.

The species examined was *Ischnoceros rusticus* Frc.

Baumann (1933) figures *Echthrus reluctator* L. which, from his figure, might belong to one of these two tribes; though it might also, but less probably, belong to the Cryptini.

F. Sphecophagini. (Fig. 27, a.)

The epistomal arch is not developed. Laterally, the epistoma and pleurostoma ascend dorsally on either side. The inferior ramus consists of two struts, one articulating with the rear of the mandible and one with the lower edge. The hypostoma

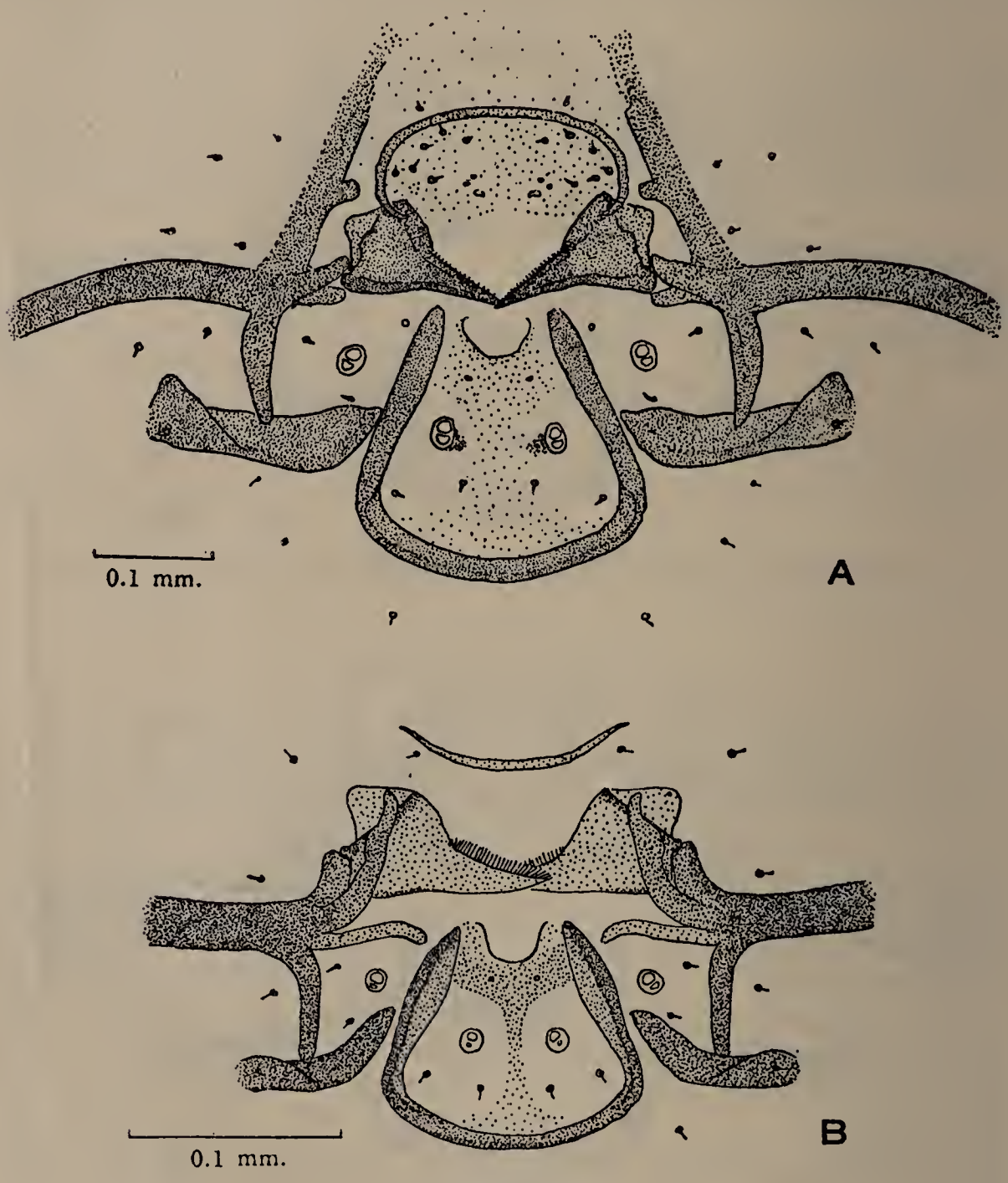

FIG. 27.

a, *Specophaga sericea* Thoms.; b, *Adelognathus* sp. indescr.

extends laterally and does not curve strongly ventrally as in the Cryptini and Phygadeuonini. The maxillary scleromes are somewhat twisted. The labial sclerome is U-shaped, wider basally, and the lateral arms are twisted in relation to the ventral portion. The facial setae are typical in number and

position; the palps each bears two sensoria. The labral sclerome is well developed. The mandibles have long, pointed blades, toothed on the upper edge (Fig. 4, h). The area enclosed by the labral sclerome bears six pairs of setae and several other sensillae.

One species was examined, *Sphecophaga sericea* Thoms. Snodgrass (1935) figures *Sphecophaga* sp.

G. Phygadeuonini. (Fig. 28, a.)

The epistomal arch is complete, but in most it is not pigmented or sclerotized, so that it appears to be incomplete. Laterally the epistoma and pleurostoma are well developed as moderately broad, well sclerotized and pigmented bars. The rami are simple projections. The hypostoma extends laterally and curves sharply ventrally on either side, ending abruptly. The maxillary scleromes are twisted and bent upwards at their anterior ends. The labial sclerome is U-shaped, wider basally, and the lateral arms are twisted in relation to the ventral portion. The typical facial setae are present, and the palps each bears two pits. The labral sclerome is always well developed, and is generally somewhat pointed middorsally. Here there may be unpigmented areas or patches, varying in number and size. These may possibly have some systematic value, but are generally not readily visible without staining. Morris, Cameron and Jepson (1937) figure them in a number of species. The labrum is moderately pigmented and bears, enclosed by the labral sclerome, four pairs of setae and two smaller sensillae. Outside the labral sclerome there are a varying number.

The chief variation occurs in the mandibles (Fig. 4, f, k), which vary in shape and in the number, position and size of the teeth on the blades. These variations may prove to have some specific or generic value.

The following species have been examined: *Demopheles caliginosus* Grav., *Microcryptus basizonius* Grav., *Acanthocryptus nigrita* Grav., *Oresbius* sp., *Hemiteles areator* Panz., *H. hemipterus* Fab., *H. longicauda* Thoms., *H. castaneus* Tasch., *H. subzonatus* Grav., *H. persector* Parf., *H. submarginatus* Bridg., *Gelis fasciatus* Fab., *G. instabilis* Först., *Panargyrops* (*Leptocryptus*) sp.

Voukassovitch (1929) figures the first-stage larva of *Hemiteles laevigatus* Ratz. Rosenberg (1934) figures *Microcryptus abdominator* Grav. Salt (1931) figures *Hemiteles hemipterus* Fab. Morris, Cameron and Jepson (1937) figure *Microcryptus basizonius* Grav. and *Hemiteles areator* Panz. Bremer and Kauffmann (1925) figure *Phygadeuon pegomyiae* Haberm.

I. Cryptini. (Fig. 28, b.)

There is no definite feature by which this tribe may be distinguished from the Phygadeuonini. The facial rods, in general, are thicker and more strongly pigmented, but the two tribes grade into each other.

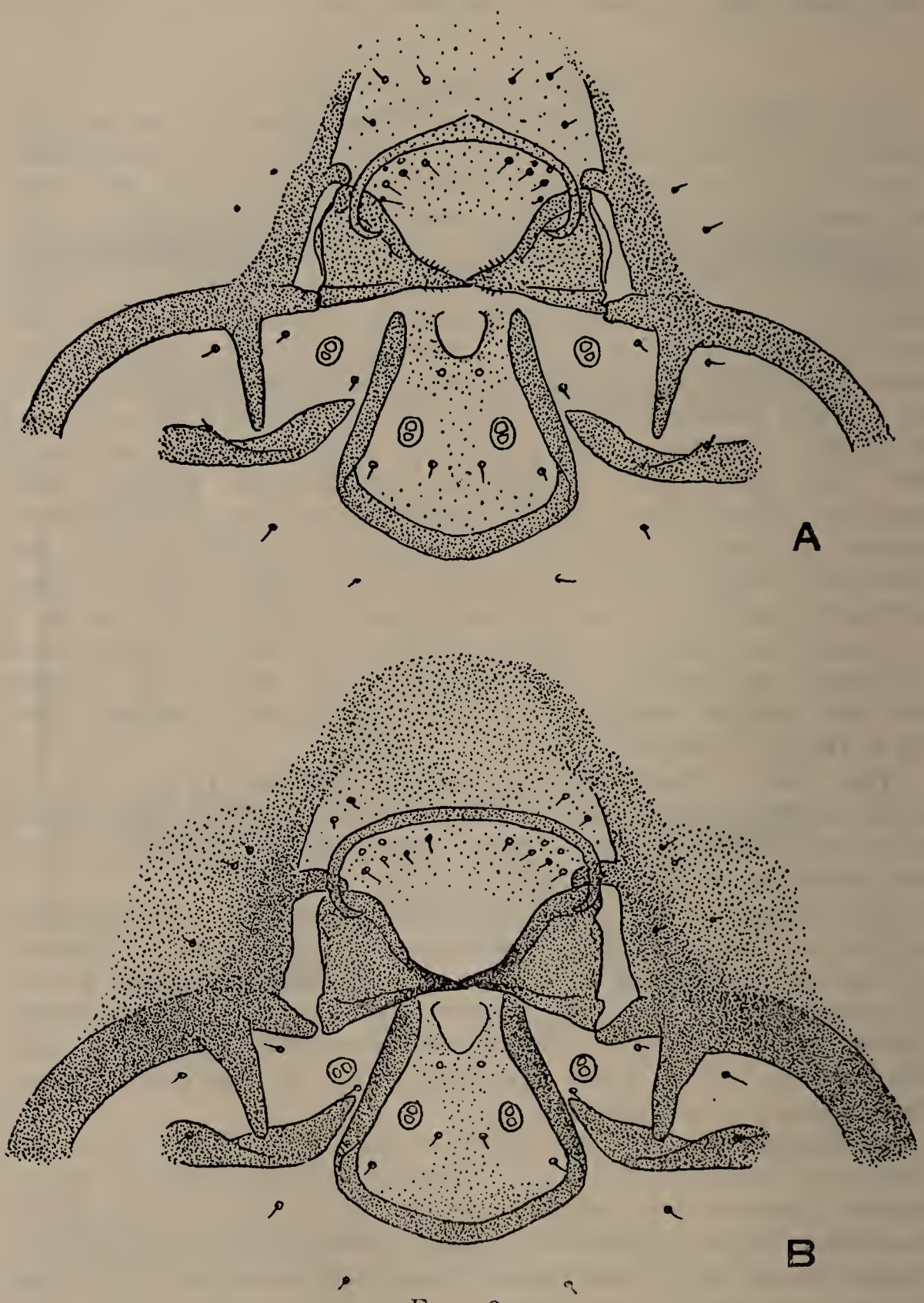

Fig. 28.

a, *Gelis* (*Pezomachus*) *fasciatus* Fab.; b, *Cryptus laborator* Thunb.

The following species have been examined: *Mesostenus obnoxius* Grav., *Spilocryptus cimbicis* Tschek, *S. migrator* Fab., *S. saturniae* Boie., *Gambrus nuncius* Say, *Cryptus laborator* Thunb., *C. albatorius* Vill., *Polyaenus curvilineatus* Cam., *Stenaraeus albinotatus* Grav., *Goryphus* sp.

Rosenberg (1934) figures *Cryptus sexannulatus* Grav. and *Spilocryptus incubitor* Ström. Morris, Cameron and Jepson (1937) figure *Spilocryptus abbreviator* Fab. and *Habrocryptus polytomi* Tschek. Janvier (1933) figures *Cryptus horstii* Brèthes.

J. Adelognathini. (Fig. 27, b.)

This is a very distinct group, showing no close relationships to any other forms.

On either side, the hypostoma extends laterally as a short, well pigmented bar, ending abruptly. From its anterior end four struts are given off. The first is the stipital sclerome, which extends ventrally to the maxillary sclerome. The second is a moderately pigmented bar, extending anteriorly from the top of the stipital sclerome, on either side; it is somewhat bent ventrally at its anterior end. The third strut extends firstly anteriorly, then curves sharply dorsally over the outside of the basal portion of the mandible; it is part of the inferior pleurostomal ramus. The fourth is a short thick bar curving dorsally and with the mandibular condyle resting in its dorsal end; this seems to be the pleurostoma. The epistoma is not developed. The maxillary scleromes are twisted, and bent upwards anteriorly. The labial sclerome is U-shaped, wider basally; and the lateral arms are not, or but slightly, twisted in relation to the ventral portion. The ligular sclerome is apparent. The typical facial setae are present; the palps bear two sensoria. There is a curved bar in the region of the labrum. The labrum is not pigmented and bears a single pair of setae. The mandibles are large, not heavily pigmented, with long, curved, pointed blades, armed with a single row of long teeth situated on the upper edge (Fig. 4, a). A rather characteristic feature is that the epicranium is heavily pigmented. In contradistinction to other forms with a pigmented epicranium the labrum and genal areas are not pigmented.

One species was examined, *Adelognathus* sp. indescr.

14. Subfamily Tryphoninae. (Figs. 29, 30, 31.)

The various tribes of this subfamily are obviously closely related to each other.

KEY TO TRIBES.

1. Large ovoid or rectangular pigmented area below labial sclerome ..... *A. Paniscini.*
   No pigmented area below labial sclerome ..... 2.
2. Mandibles apparently without teeth; hypostoma curving sharply downwards to below level of maxillary sclerome ..... *B. Cteniscini.*
   Mandibles with teeth ..... *C. Tryphonini.*

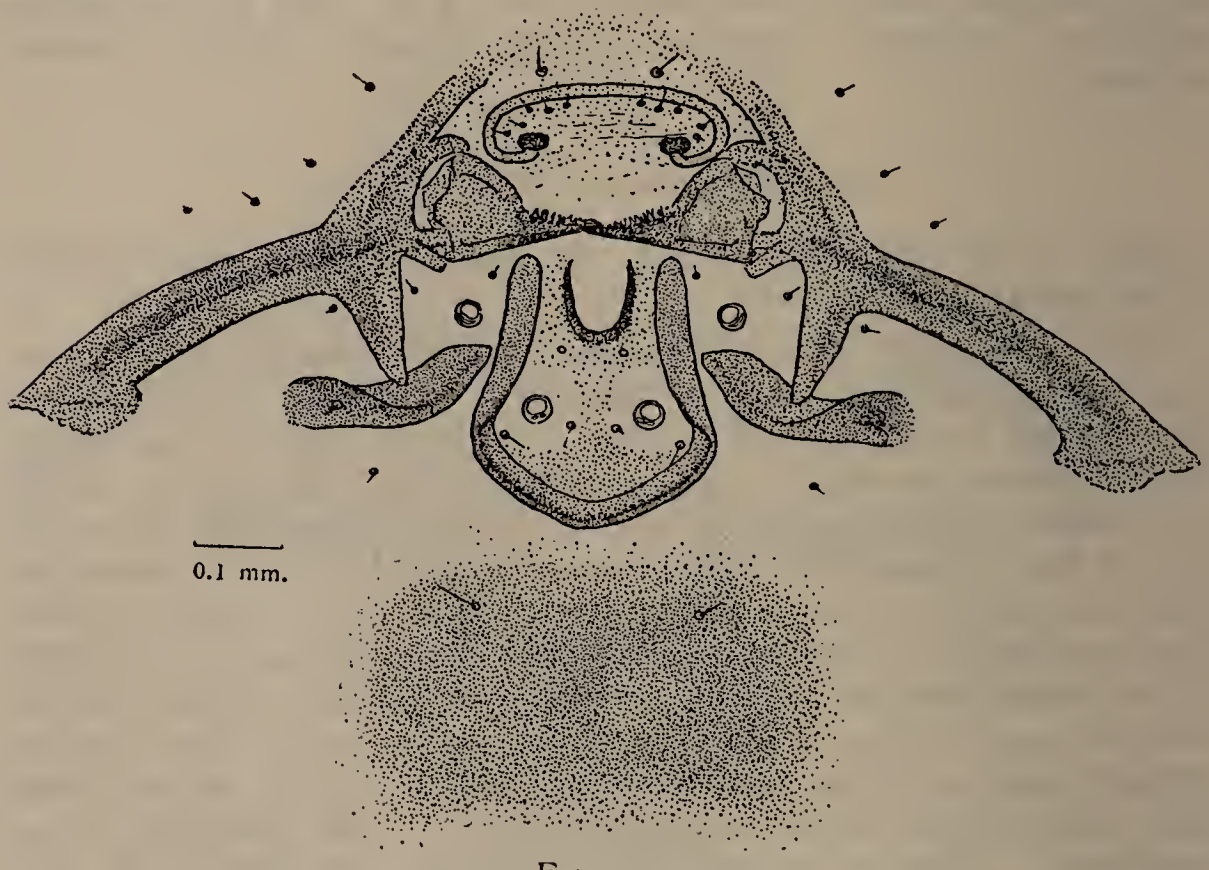

FIG. 29.
Paniscus vinulae Scop. (*cephalotes* Hlgr.).

A. Paniscini. (Figs. 29, 30.)

KEY TO GENERA.

1. Mandibles with a single row of teeth ..... *Phytodietus.*
   Mandibles with two rows of teeth ..... 2.
2. Labral sclerome terminating in a knob at each end ..... *Paniscus.*
   Labral sclerome not terminating in a knob at each end ..... *Parabatus.*

The epistomal arch is complete but sometimes less well pigmented dorsally than laterally. The pleurostoma is broad; the inferior ramus is divided into two. The hypostoma extends laterally and somewhat ventrally on either side as a broad, slightly curved bar ending in a slight lateral enlargement: it is strongly pigmented, particularly down the mid-line. The stipital scleromes are broad; the maxillary scleromes are twisted and somewhat bent upwards at their anterior ends. The labial sclerome is U-shaped, wider basally and rounded

or slightly pointed ventrally; the lateral arms are twisted in relation to the ventral portion. Below the labial sclerome there is a large ovoid or rectangular pigmented area on which is situated a pair of setae. The facial setae are typical in number and position. Each palp bears one large and one, or sometimes two, small sensoria. The edges of the orifice of the silk duct are pigmented. The labral sclerome is well developed and in *Paniscus* it appears to terminate in a knob at each end. In *Parabatus* and *Phytodietus* the ends rest on the outsides of the mandibles in the normal way. The mandibles

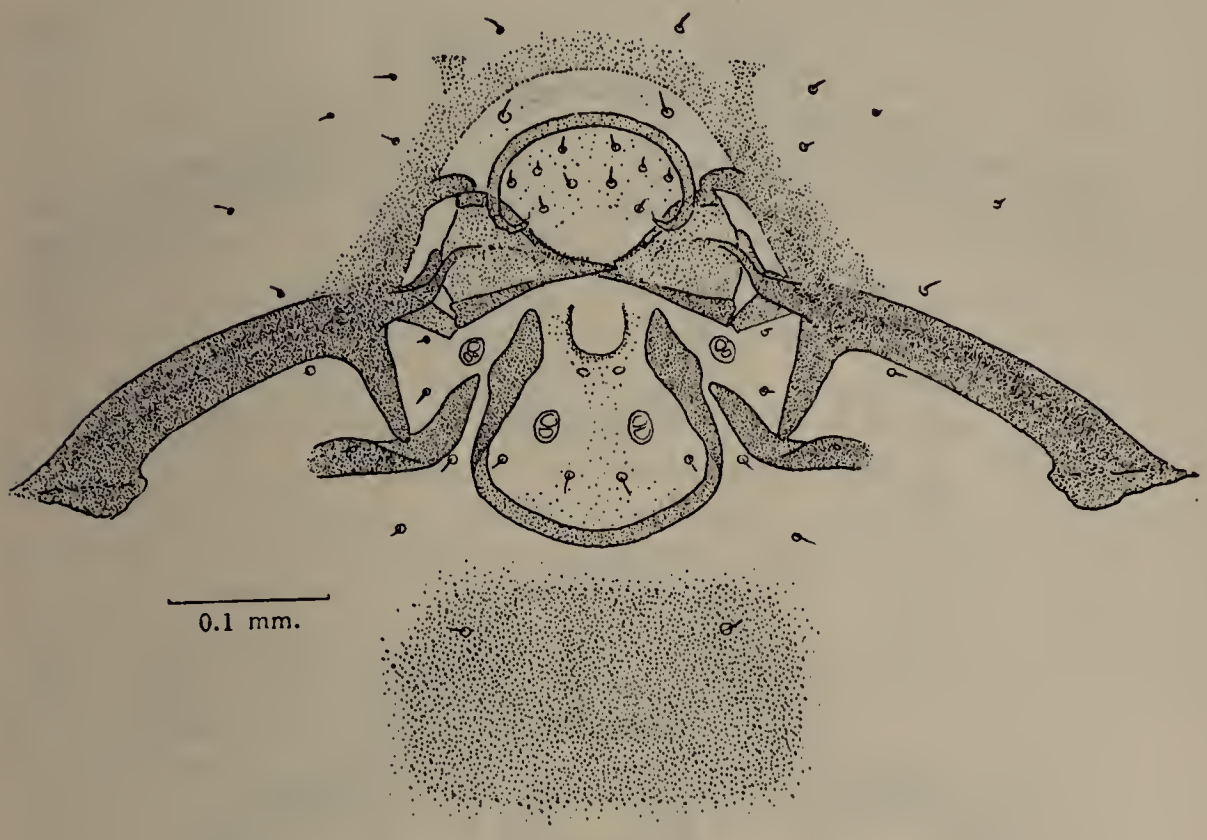

Fig. 30.
Phytodietus coryphaeus Wesm.

have long pointed blades with a row of large teeth on the upper edge and a very much reduced lower row on the outside of the blade near the tip (Fig. 4, n). The labrum bears six pairs of setae, of which five are within the labral sclerome.

The following species were examined: *Paniscus melanurus* Thoms., *P. vinulae* Scop. (*cephalotes* Hlgr.), *Parabatus cristatus* Thoms., *P. virgatus* Frc., *Phytodietus coryphaeus* Wesm. Newport (1849) figures *Parabatus virgatus* Frc.

B. Cteniscini. (Fig. 31, b.)

This tribe shows a close relationship to the following but differs from it in that there are no teeth on the mandibles.

The epistomal arch is complete and well pigmented. The anterior tentorial pits are apparent. The pleurostoma is well

developed and the inferior ramus is divided into two, as in the previous group. The hypostoma extends laterally on either side, curving strongly ventrally. The positions of the posterior tentorial pits are apparent. The maxillary scleromes are somewhat twisted and are bent upwards at their anterior ends; the labial sclerome is as in the previous groups, the lateral arms

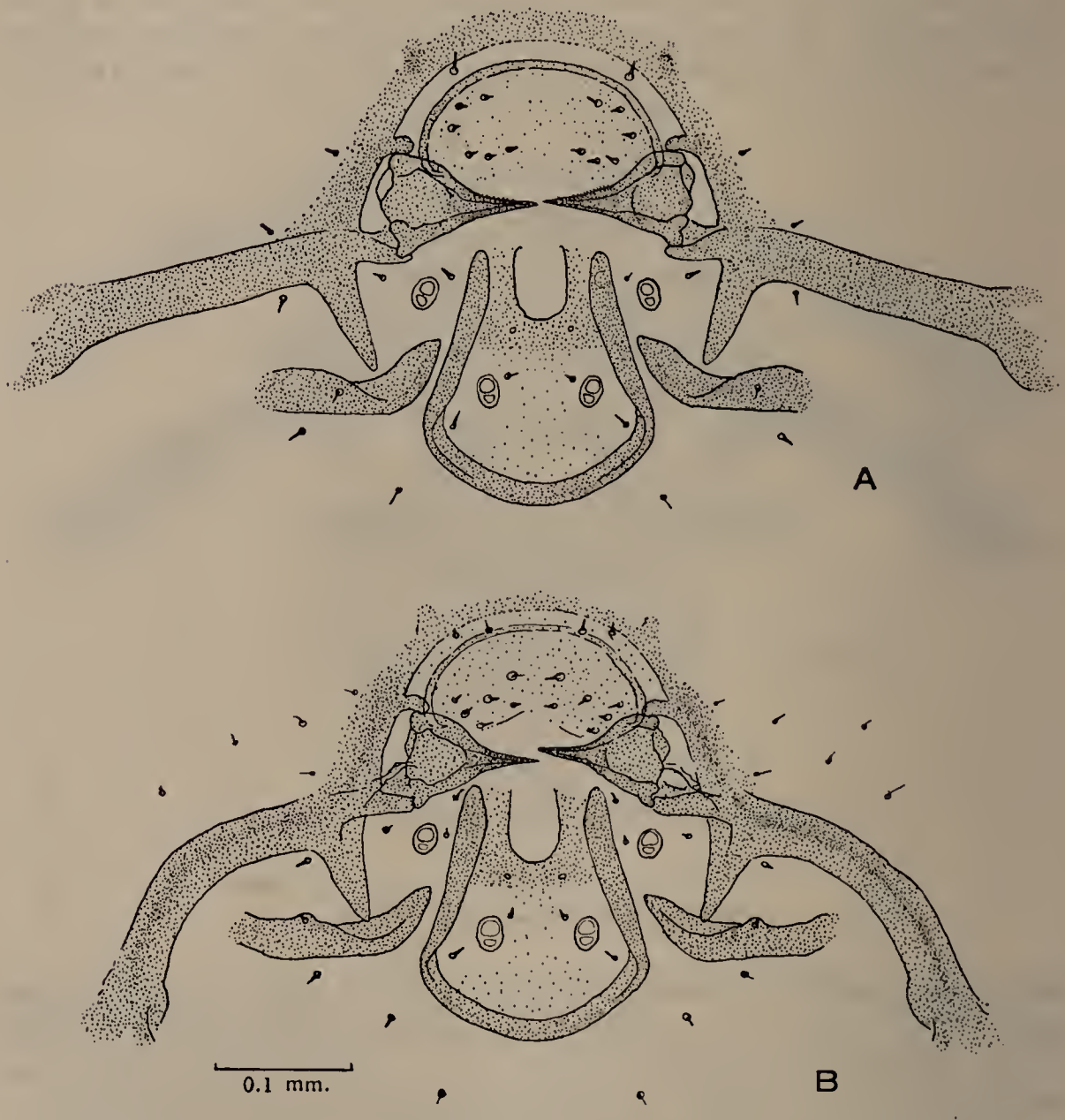

Fig. 31.

a, *Eclytus fontinalis* Hlgr.; b, *Exenterus adspersus* Htg.

being twisted in relation to the ventral portion. As in the Tryphonini the area immediately below and lateral to the orifice of the silk duct is pigmented. The typical facial setae are present, and the palps have two sensoria. The labral sclerome is well developed, the ends resting on the mandibles, which are shaped like those of the previous group but are without any trace of teeth (Fig. 4, o). The presence of the labral

sclerome would seem to suggest that this is a secondary modification. On the labrum there are eight pairs of setae, six of which are enclosed by the labral sclerome.

The following species were examined: *Exenterus adspersus* Htg., *E. marginatorius* Fab., *E. tricolor* Rom., *E. abruptorius* Thunb. Morris, Cameron and Jepson (1937) figure *E. tricolor* Rom.

C. Tryphonini. (Fig. 31, a.)

The epistomal arch is complete and pigmented to a degree equal to that of the other facial rods; the anterior tentorial pits are apparent, and the pleurostoma is also well developed. As in the previous two tribes, the inferior ramus consists of two struts, one articulating with the rear, and one with the basal part of the mandible. The hypostoma extends laterally and somewhat ventrally, on either side, as a straight bar. At its posterior end the position of the posterior tentorial pit may be made out. The maxillary scleromes are twisted and slightly bent upwards at their anterior ends. The labial sclerome is of the typical *Paniscus* shape, U-shaped with the lateral portions twisted in relation to the ventral. The typical facial setae are present, and the palps bear two sensoria. The labral sclerome is well developed, its ends resting on the outsides of the mandibles, which have long pointed blades ornamented with a row of teeth on the upper edge. The labrum is moderately pigmented and bears seven pairs of setae, six of which are enclosed by the labral sclerome.

The species examined was *Eclytus fontinalis* Hlgr.

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Summary.

The homologies of the various cephalic structures of the larva with the structures of the adult are considered and the nomenclature of the various parts is discussed. The structure of the tentorium, the spiracles and the mandibles is considered. The classification of the Ichneumonidae is discussed and a classification, revised by Mr. J. F. Perkins, of the species studied for the present work is given.

The final instar larvae of approximately 200 species of Ichneumonidae have been examined for the present paper and a further fifty species are figured in the literature. The larvae were found to show definite subfamily, tribal and sometimes generic characters, but definite specific characters have not been found. A consideration of the larval characters throws light on a number of obscure points in the classification, but there are some anomalous forms.

Keys are given for the separation of the larvae of the Chalcidoidea, Ichneumonidae and Braconidae, for the identification of the different subfamilies of the Ichneumonidae, for the tribes in their respective subfamilies, and in some cases for genera. The head-capsules of fifty-five species, belonging to thirty-seven tribes, are figured.

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